The Welding Engineer

Edited by L. B. Mackenzie

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AIRCO DAVIS APPARATUS

ANYTHING AND EVERYTHING
FOR OXYACETYLENE WELDING AND CUTTING

Public faith in a product is a reflection of faithful performance. Thus, consistently, have Airco Oxygen and Airco Acetylene built up good-will.

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Speeding Production via the Oxweld Cutting Torch

It is astonishing what big dividends in time and money a little thought behind Oxwelding and Cutting outfit will produce.

Here is shown an example of how a manufacturer of oxy-acetylene cutting and welding apparatus uses oxwelding to speed the production of one of his products.

Here the operator is cutting openings for fittings and upper parts of the chamber of an acetylene generator. If the cutting blowpipe were not used, a punch press and dies, or extensive drilling would be required. The punch press, representing a big investment would be often idle, and the other method is so slow as to be prohibitive in cost.

The oxy-acetylene apparatus, however, being standard shop equipment, is used in the cutting intervals for welding the seams, heads and fittings of the same generator. There are a thousand ways—big and small—whereby it quickly pays for its installation.

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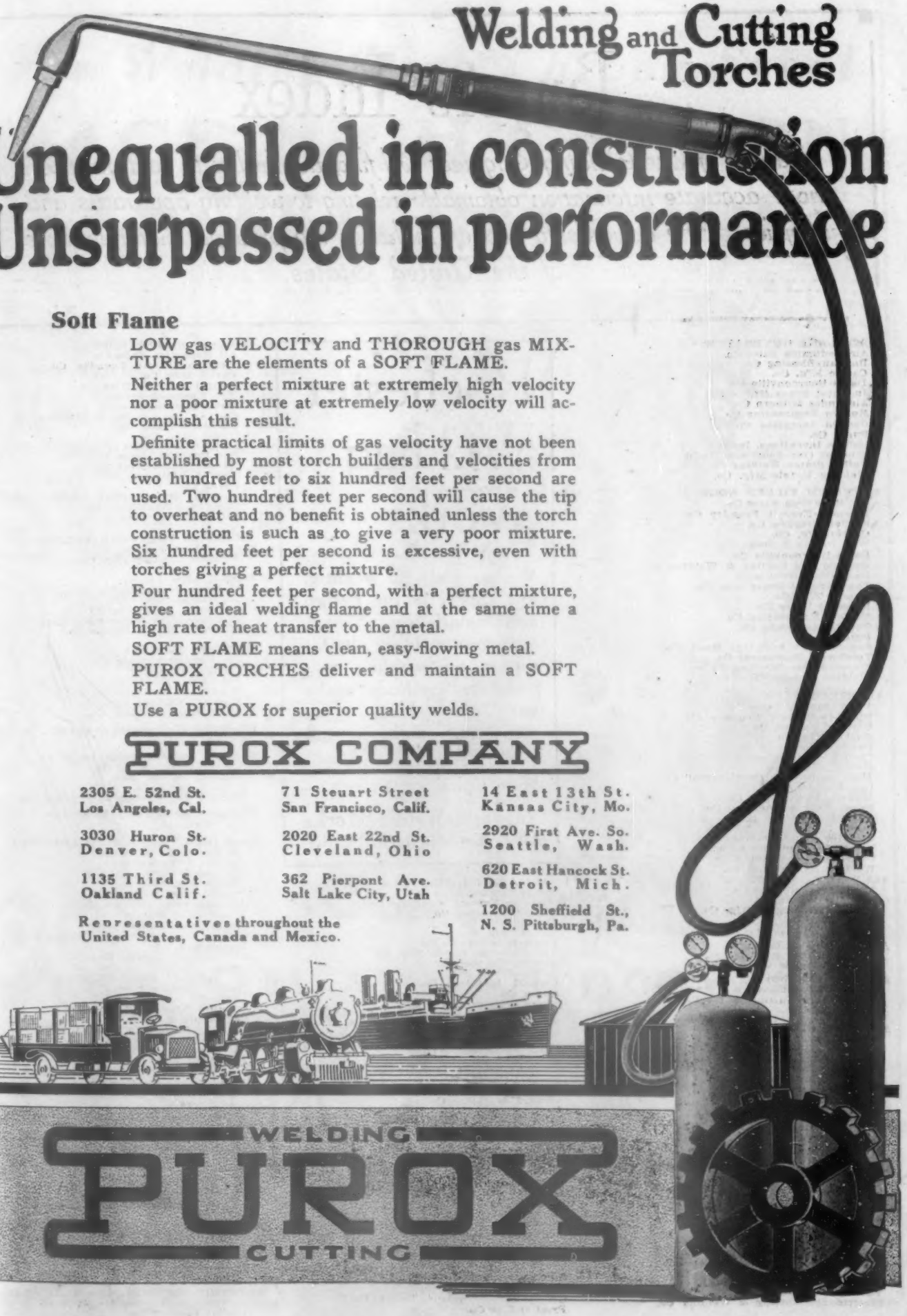
Unequalled in construction
Unsurpassed in performance



Soft Flame

LOW gas VELOCITY and THOROUGH gas MIXTURE are the elements of a SOFT FLAME.

Neither a perfect mixture at extremely high velocity nor a poor mixture at extremely low velocity will accomplish this result.

Definite practical limits of gas velocity have not been established by most torch builders and velocities from two hundred feet to six hundred feet per second are used. Two hundred feet per second will cause the tip to overheat and no benefit is obtained unless the torch construction is such as to give a very poor mixture. Six hundred feet per second is excessive, even with torches giving a perfect mixture.

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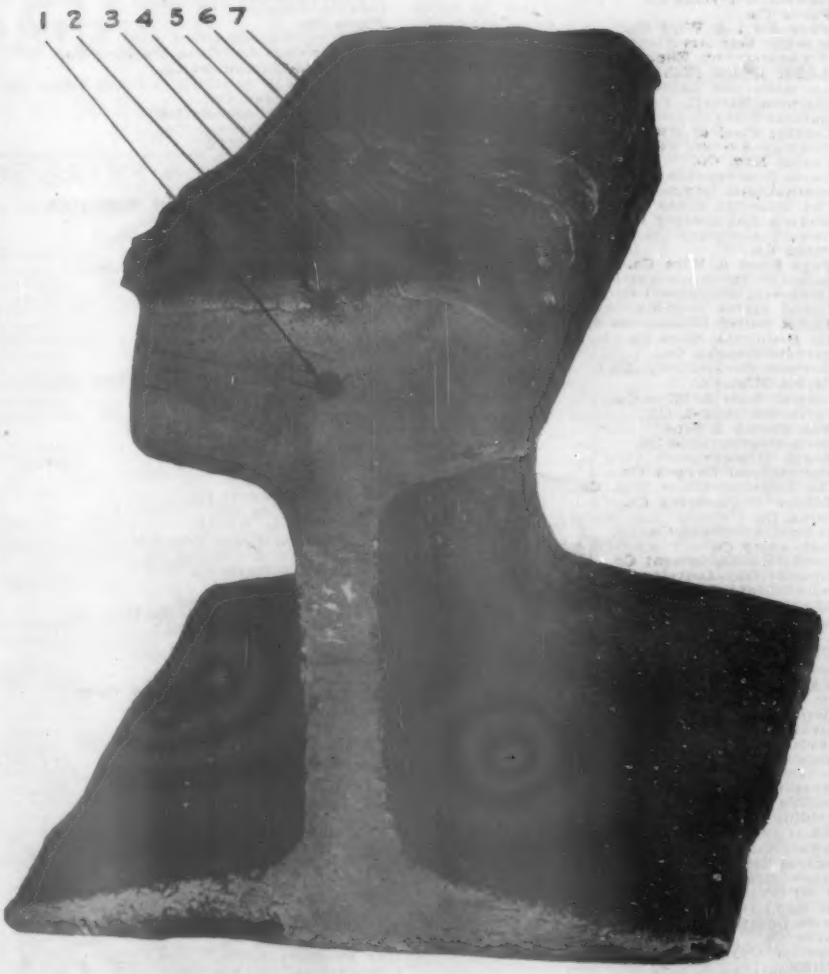
Conform in all respects to A. W. S. specifications.

Look for red tag and red-colored ends.



Hardness Analysis
(Scleroscope)

1	(Original Metal)	30
2		31
3		31
4		32
5		33
6		35
7		37

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Jackson.....172 South Water St.
Lansing.....617 E. Shiawassee St.
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Saginaw.....1830 N. Michigan Ave.
Sault Ste. Marie.....

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Minneapolis.....334 N. First St.
Virginia.....413 Chestnut St.

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Vicksburg.....1701-3 Levee St.

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Kansas City.....1422 St. Louis Ave.
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Omaha.....1007-9-11 Jones St.
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Camden.....Front and Division Sts.
Newark.....251 Ridgewood Ave.

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Williamson.....P. O. Drawer L

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ALPHABETICAL INDEX TO ADVERTISERS

Amling, H. G.
Air Reduction Sales Co. ..... Front Cover
American Welding Society 14

B
Bastian-Blessing Co., The 26-27
Bierman-Everett Fdy. Co. 50
Buffalo Dental Mfg. Co. 45
Burdett Mfg. Co. 10

C
Carbic Mfg. Co. ..... Inside Back Cover
Major James Caldwell 39
Central Steel & Wire Co. 38
Chicago Eye Shield Co. 50
Chicago Steel & Wire Co. 8
Commercial Acetylene Supply Co. 9
Wm. Cramp & Sons 16

D
Davis-Bournonville Co. 50
M. Keith Dunham 17

E
Electric Arc Welding & Cutting Co. 48

F
Federal Brass Works 45

G
Gas Products Assn. 13
Gas Tank Recharging Co. 45
General Electric Co. 35

H
Harris Calorific Co. 4
Hauck Manufacturing Co. 14

I
International Oxygen Co. 50
Imperial Brass Mfg. Co. 50

K
K-G Welding & Cutting Co. 39

L
Linde Air Products Co. 18

M
Manganese Steel Forge Co. 49
Mattingly Automatic Valve Co. 49
Alexander Milburn ..... Back Cover
Modern Engineering Co. 49
Morey Flux and Chemical Co. 50

N
National Carbon Co. 50

O
Oxweld Acetylene Co. 2

P
Page Steel & Wire Co. 5
The Prest-O-Lite Co., Inc. 31
The Purox Co. 3

Q
Quasi-Arc Weldtrode Co. 50

R
Reid-Avery Co. 15
Rochester Welding Works 4
Roebling, John A., Sons Co. 17

S
Sall Mountain Co. 48
Selboral Co. 48
C. Sorenson 48
Superior Oxy-Acetylene Machine Co. 49
Southern Welding Machine Co. 6
Shawinigan Products Corporation 16
Smith's Inventions, Inc. 11
Standard Carbide Sales Co., Inc. 12
N. A. Strand & Co. 50

T
Torchweld Equipment Co. 43
Transportation Engineering Corp. 14

U
Union Carbide Sales Co. 7
U. S. Gauge Co. 49
United States Welding Co. 37

W
Welding Metals Mfg. Co. 49
Westinghouse Electric Mfg. Co. 50
Wm. Wharton, Jr., & Co., Inc. 43
Wilson Welder & Metals Co. 43
Wodack Electric Tool Corporation 48

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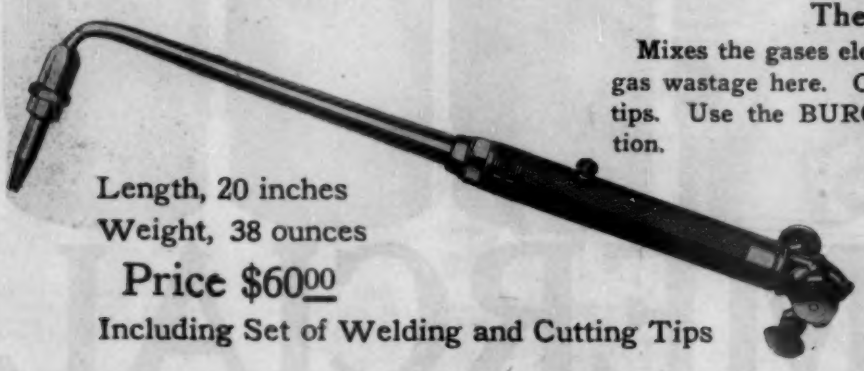

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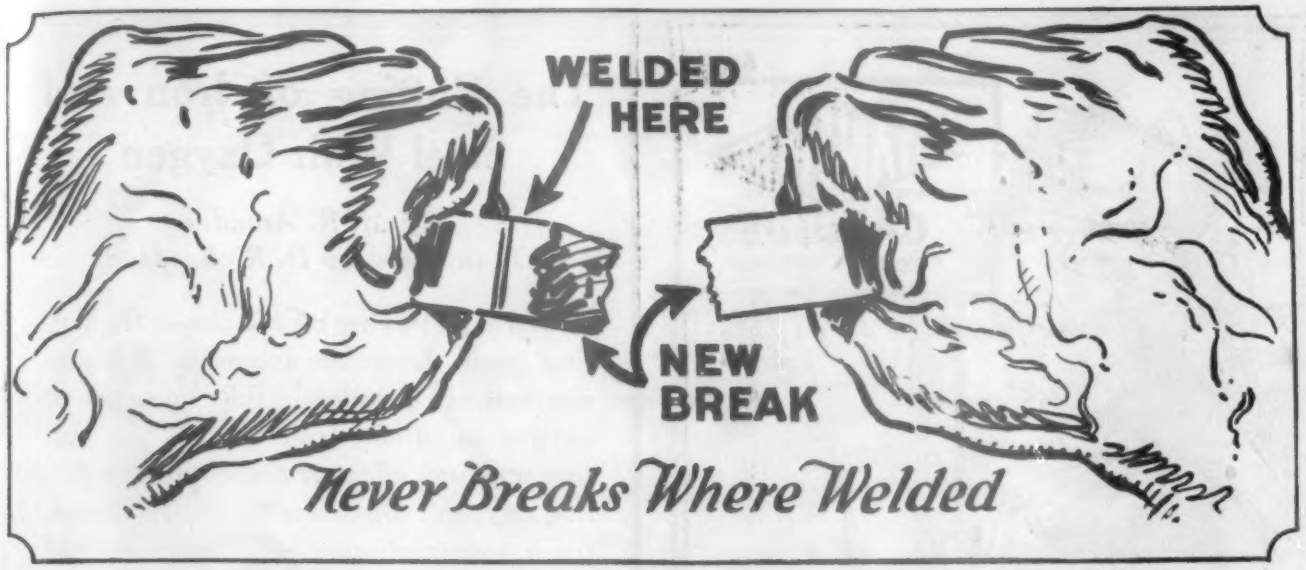

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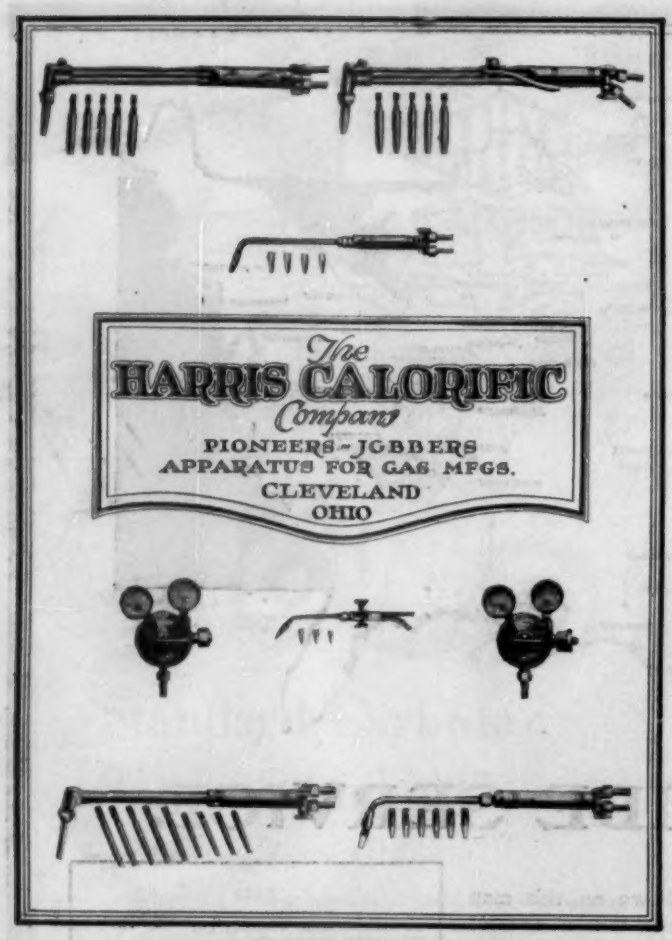

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This wire may be used with success wherever imported Norwegian or Swedish wire has been considered necessary.

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Analysis:

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Manganese	0.30-0.60%
Phosphorus	not more than 0.04%
Sulphur	not more than 0.04%
Silicon	not more than 0.04%

for welding with direct current high carbon steel and worn surfaces where great resistance to abrasive wear is desired such as rails, frogs, switch points, bearing surfaces, etc.

"RACO" HIGH CARBON COVERED

Analysis:

Carbon	0.85-1.10%
Manganese	0.30-0.60%
Phosphorus	not more than 0.04%
Sulphur	not more than 0.04%
Silicon	not more than 0.04%

for welding with alternating current high carbon steel and worn surfaces where great resistance to abrasive wear is desired, such as rails, frogs, switch points, bearing surfaces, etc. This wire is manufactured especially to conform to specifications E-No. 1C of the AMERICAN WELDING SOCIETY.

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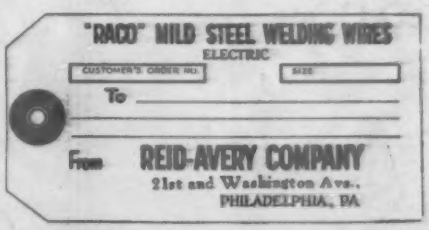

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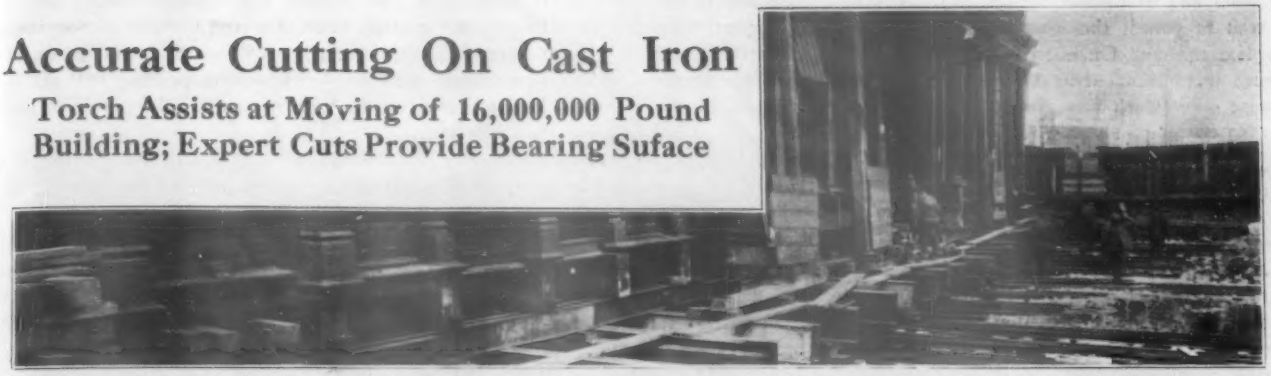

ONE of the favorite questions for discussion at meetings of welders has been the possibility of cutting iron castings with the oxy-acetylene torch. It has always been possible to find one or more skeptics who would declare such a job to be both impossible and impractical, and when specific jobs were cited it would be pointed out that the sections were merely melted apart, consuming in the operation a quantity of gas all out of proportion to the importance of the work, and leaving a wide, ragged kerf which defeated the utility of the process for anything except wrecking work. In fact, the best believers in cast iron cutting have been so conservative in expressing their views of its possibilities that there has been little or no attempt to use the torch where smoothness and accuracy were necessary. The following discussion which describes the cuts made on the cast iron columns of a seven story building, will therefore throw new light on the subject and suggest interesting possibilities for further development of the process.

The building shown in Figure 1, known as the Dowie building, is about thirty-three years old. From 1890 to 1907 it stood at the corner of Randolph and Clark Streets, Chicago. In 1907 it was moved in sections to the southeast corner of Michigan

Fig. 1. Dowie Building Moved 85 Feet to Allow Street to Be Widened.

Avenue and Twelfth Street. Since that time the greater portion of the building has been used by the Illinois Central Railroad as an office building. During the past summer the firm of Wm. H. Brown & Co., Engineering Contractors, Chicago, have been engaged in moving this building intact eighty-five feet, to allow for the widening of East Roosevelt Road (Twelfth Street) from 33 feet to 118 feet. The building is of brick construction, with cast iron and steel frame, seven stories (about 100 ft.) high, and is estimated to weigh about 16,000,000 pounds. The work done by Wm. H. Brown & Co., consisted in moving it eighty-five feet south and six inches west, and turning it through an angle of five degrees.

In order to make possible the moving of this large structure a solid network of heavy steel beams were placed under the entire building, as well as a solid area of heavy timber cribbing. The building was pulled over steel rollers laid on many lines of railway rails which were supported by the cribbing. The cribbing was built solid over the entire area of the new foundation as well as under the building in order to facilitate the work and reduce the length of time the building was on the rollers. When all preparations had been made the actual moving time was about twenty hours. Accurate measurements showed that the subsidence of the building when loaded on the rollers was less than half an inch. Altogether it was an unusually fine bit of engineering claimed to be entitled to the world's record for such moving jobs, and it has attracted a great deal of interest in engineering circles in Chicago. The job has particular interest for the editors of *The Welding Engineer* because several years ago, while engaged in publishing other business papers they occupied offices on the second floor of this building.

In a work project of this size there is always enough welding and cutting to keep a torch fairly busy. The feature task for the cutter on this job was the cutting of thirty-six cast iron columns below the first floor level, before I-beams were placed under the building, not because the use of the torch was so essential to the success of the job but because the cuts were made so accurately and so smoothly as to save considerable time and

Fig. 2. Type of Cast Iron Columns Which Were Cut.

labor by providing bearing surfaces for these supports on the new foundation.

In Figure 2 are shown cut sections of the three types of iron columns which formed a part of the old foundation. A, B, and C are rectangular, round, and cross columns, respectively. The rectangular and round columns are hollow, the rectangular ones slotted on one side, and the metal in all sections is one and one-half inches thick. The arrow at x indicates one of the first cuts made, with no sign that accuracy and smoothness are possible. Before the work had progressed very far it was pointed out by Welder Edward Nelson, an "old-timer" at handling the torch, that skillful work would be worth while, and he was given entire charge of the remainder of the cutting operations. The result of his expert handling of the cutting flame is evident at

the other end of the cut section (*y*). The procedure was to cut a notch to permit the insertion of an I-beam for support, then complete the cut. On one of these rectangular columns the total cutting was estimated at 108 inches. Speed was quite a factor because other work was always waiting on the completion of the cuts, so no attempt was made to save gas.

A collection of cuts which are good examples of both smoothness and accuracy is shown in Figure 3. (a) is a straight cut on one of the rectangular columns. This photograph shows clearly that it is quite possible to follow a straight line on cast iron with the cutting torch and leave a surface which very closely approaches a steel cut for smoothness and neat appearance. (b) is a column which was cut so roughly the first time that it had to be gone over a second time in order to line up properly. Irregularities in the first cut extended above the bearing line, so a notch was cut to get rid of them and two steel plates inserted to fill out the gap. Another example of accuracy. (c) is one of the cross beams, resting on two parallel I-beams on the new foundation. The member (A) and the one opposite rest on the

Fig. 3. Close-Up Views of Some of the Cuts.

I-beam (B), while the member (C) and the one opposite extend down between the beams. The two beams were, of course, exactly level and on line, so the cutter had to do some exacting work here. (d) is an iron patch cut to fit a gap in the corner. The hole at (A) here was cut against a brick and mortar surface.

These examples will serve to show that there was quite a bit of variety in the cutter's work. The next photograph (Fig. 4) is of a series of the rectangular columns on the north side of the building, and illustrates the uniformity of the results that were secured throughout. Every one of these cuts provided a perfect bearing and was perfectly aligned with all the others. Figure 5 shows one which was nicked to fit I-beams placed at slightly different levels.

Work of this quality is possible only after considerable practice has developed skill in manipulating the torch, yet the procedure involved has been clearly outlined, so that one familiar with the use of the cutting torch on steel can develop the necessary skill. *The Welding Encyclopedia* says:

"In practice, cast iron cutting differs from steel cutting in that:

(a) It is necessary to use heating flames having an excess of acetylene.

(b) It is necessary to hold the torch nozzle farther away from the metal.

(c) It is necessary to preheat for a longer period for cast iron than for steel, since cast iron must be almost molten before the cutting reaction will start. Steel ignites at a temperature well below its melting point.

(d) It is necessary to continually oscillate the nozzle to maintain the cut.

A cast iron cut, if properly handled, and if the material is of good quality, will have an appearance about equal to that of a fair cut in steel.

The time required for cutting a given section of cast iron is about twice that required for cutting a similar section of steel. This makes the cost considerably higher in the instance of cast iron and tends to restrict its applications in many places where one might suppose it would be generally useful.

Instructions for Cutting Cast Iron

The torch manipulations for cutting good grades of cast iron and for cutting poor grades of cast iron are quite different and are both described below. Although there is a difference in the manipulation of the torch, the oxygen pressure used and the adjustment of the flame are the same for both grades of metal.

Method for cutting good grades of Cast Iron:

(1) Adjust oxygen cutting regulator to give the correct pressure for the work to be done, having the cutting valve open. Then close cutting valve.

(2) Open oxygen valve one-half turn and acetylene valve fully and light torch. Open cutting valve and adjust acetylene valve to give flames having an excess of acetylene, the length shown in the cutting chart. Then close cutting valve.

(3) Hold torch so that the nozzle points backward at an angle of 45 deg., with the inner cones (not the excess cones) ⅛ to ¼ inch above the surface, give the nozzle a swinging motion describing semi-circles over the end of the line of cutting and heat a semi-circular area about ½ to ¾ inch diameter to a bright cherry.

(4) Move nozzle just off the heated edge, open cutting valve quickly and move nozzle (at 45 deg.) forward along the line of the cut with the same swing motion.

(5) While advancing the nozzle gradually straighten it up so that it is about 75 deg. pointing backward when at the inner edge of the previously heated semi-circular area.

(6) Advance nozzle about ¼ inch to burn off the molten

surface, then quickly move it backward to burn through the comparatively dark layer and lower section, then hold it steady for a moment to heat the upper surface.

This movement can be best practiced by counting as follows: 1 forward, 2 back, 3 hold; 1 forward, 2 back, 3 hold, etc., etc.

(7) Continue moving nozzle in this manner at the rate of about one complete cycle per second.

(8) When the far edge is reached carry nozzle over the edge and across the other surface, holding it at about the angle of the lag, and cut through the lag section.

Method for Cutting Poor Grades of Cast Iron

Follow the directions given for cutting good grade grey iron, except that instead of using the peculiar motion explained, advance the nozzle slowly, describing semi-circles from about ¼ to ½ inch wide across the line of the cut, holding the torch at about 75 deg. pointing backward.

Notes on Cast Iron Cutting

In cutting cast iron a dark layer will be found extending down from the top surface about 1 to 1½ inch. Below that layer the material will be bright, having an appearance about the same as steel.

Be sure that the forward and backward, or the semi-circular movement of the nozzle allows the torch to cut almost perpendicularly through the dark layer. The lag must not start until below that section. Particular attention must be paid to this condition.

If cut is lost, move nozzle back along one edge of the kerf about ½ inch and describe semi-circles lapping that edge and that point where the cut stopped. If the cut is not readily resumed, carry the semi-circles over to include both edges of the cut and the point where the cut stopped.

Always wear heavy asbestos gloves and suitable clothing to protect the body, face and head, because cast iron cutting is a very much hotter operation than steel cutting.

Always make sure of ample protection from the heat before starting so that it will not be necessary to stop the cutting operation to take shelter or provide further protection.

Fig. 4. A Group of Cast Iron Columns Cut With the Torch Showing How Accurate Work Gave Perfect Bearing.

Fig. 5. Cast Iron Cut to Fit Irregular Space.

Fig. 6. Starting the Cut on Rectangular Column.

Cast Iron Cutting Chart

Thickness of mental, in	Length of Excess acetylene, in
½ to 2	1 to 1½
3 to 12	1½ to 2

When it is necessary to follow a line exactly with the cutting torch it is well to start heating the casting an inch or so below the line if conditions permit, as in (a), Figure 6. The flame is directed slightly away from the casting and given a counter-

clockwise circular motion. As the high pressure oxygen line is opened the flame is brought steadily up to the line as in (b), Figure 6. The circular motion is continued and the flame gradually turned toward the casting as penetration is secured. In (c) Figure 6 the torch has been extinguished so that its position can be seen clearly at the time when the cut is ready to progress along the line.

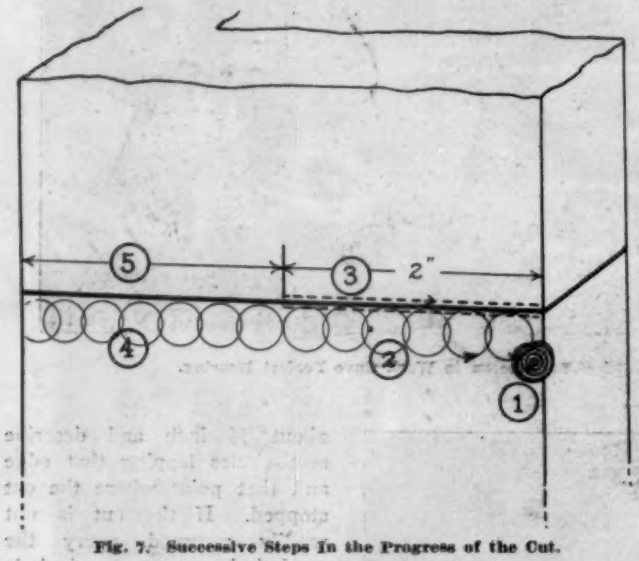

Fig. 7. Successive Steps in the Progress of the Cut.

After about two inches of progress have been made the torch is drawn backward along the upper edge of the kerf, to smooth out the irregularities in its surface. This takes only an instant, and the cutting is at once resumed before the metal has a chance to cool, the smoothing process being repeated every two inches. Successive steps in the progress of the cut are shown in Figure 7.

Fig. 8. Showing Position of Torches Cut Progresses.

(1) Cut is started slightly below line. (2) Cutting progresses about two inches forward. (3) Torch is brought back to smooth off upper surface (4) Cut forward (5) smooth off surface just cut, and so on until the cut is completed. When sand holes are encountered the circular motion is reversed to the clockwise direction until the cut has progressed through the hole, then the original motion is resumed. Close-up photographs of this procedure are shown in Figure 8, with the torch extinguished at (c) to allow a clear view of the appearance of the cut and the position of the torch. Notice how the left hand is used to steady the torch, heavy gloves furnishing protection from the heat. The pressures used here were 10 to 12 pounds acetylene and from 30 to 60 pounds oxygen. The thickness of the metal is one and one-half inches. After the cutting was started it proceeded at the rate of about an inch a minute.

All cuts were on upright columns, and the majority of them in difficult positions as the amount of cribbing and moving materials already in position created some very awkward working conditions. The cutter was also working under pressure most of the time because his work was usually called for at the last minute and he had a limited amount of time in which to get through and make room for the materials to be put under the columns. On one occasion he was cutting a circular column and the burning dust inside it sent up great clouds of smoke which found their escape in the seventh story, and caused a patrolman to turn in a fire alarm. In ten minutes both sides of Michigan Avenue were lined with fire-fighting apparatus and nobody could find a fire.

Fig. 9. Cut-off Columns, Showing Close Quarters in Which the Cutter Was Obliged to Work.

When they finally guessed what caused the smoke it took the firemen twenty minutes to locate the cutter with his outfit in the maze of timber and steel underneath the building. That this cutting was not done in a leisurely manner in a laboratory but under pressure and in the midst of awkward working conditions. The cut-off sections of columns in the old location of the building as shown in Figure 9 also show how the quality of the work may vary with the skill of the operator.

Because of the unusual excellence of the cuts the work of cutting the iron columns has been given a very full discussion here. There were many other time and money saving jobs for the oxy-acetylene torch. Ends of I-beams protruding from the cement columns of the new foundation had to be cut off. The old fire escape was removed with the cutting torch. A tractor trailer was dismantled and remodeled, using a cutting torch to remove the rivets, and fabricate new members. Capstans used in the moving were made from materials at hand, and oxy-acetylene welded. There is almost no end to the number of miscellaneous jobs which a clever operator can do where this sort of work is going on.

Acknowledgment is made to Mr. C. C. Ebright, of the K-G Cutting and Welding Co., Mr. Phillipi and Mr. Laycock, of the Wm. H. Brown Co., for kind assistance in compiling the information and securing photographs for this article.

At a meeting of the New York Section of the American Society of Refrigerating Engineers, which was held on Thursday evening, October 11, at the Machinery Club, Prof. A. S. Kinsey, of Stevens Institute of Technology, read a paper on Oxy-Acetylene Welding and exhibited motion pictures of oxygen and acetylene production and oxy-acetylene welding and cutting.

The Prest-O-Lite Co., Inc., New York, will soon erect a new branch plant at Tulsa, Oklahoma, according to a recent report.

At a meeting of the American Welding Society, Metropolitan Section, New York, November 13th, Major James Caldwell, managing director of Alloy Welding Processes, Ltd., London, read a paper on "Fluxes and Their Functions in Electric Arc Welding."

ARC WELDING APPARATUS*

Physical Features of the Arc—Characteristics of Common Types of Apparatus—Various Methods Compared

By J. Caldwell

Summary

THE intention of this paper is to deal with the physical features of the iron arc used for welding ferrous metals, so far as those features are known, indicating some of the lacunæ in present knowledge; and to describe the general types of apparatus and equipment which have been developed, illustrated by some examples of each type, and some of recent design which promise well.

The two branches of the subject are directly connected, because the apparatus must conform in its performance to the conditions of the welding arc and to the requirements of the welder.

Operating or workshop methods are touched on only so far as they illustrate or determine, or are determined by, the physics of the welding arc and the practical requirements of welding.

Working methods and applications of arc welding have been described in several recent contributions to other Institutions and Associations, in technical journals, and in books, reports, etc.

(1) The State of the Art

Arc-welding practice is in advance of theory. It is an established fact that good welds can be made on any ferrous material if certain conditions are observed, and the standardization of these conditions has been established for many applications by empirical methods. As usually happens in an empirical art, there is considerable divergence of opinion on many points which can only be reconciled by the establishment of exact knowledge.

Arc welding was originally tried for repair work, either because there was no other method, or because it was evidently quicker and cheaper than any other. It was looked on with suspicion, but when time was of importance and new parts were not readily obtained, the successful use was worth risking and failure did not harm the existing position. During the war the conditions favouring such trials were intensified, and the generally good results obtained greatly widened the applications, developed welding as a regular repair process and led to its adoption for constructional work.

Ship repairers led the way in this empirical development, assisted by their wide knowledge of ferrous materials and methods of joining them up into structures exposed to severe, complex stresses. They have had the co-operation of electrical engineers, metallurgists and chemists, who have investigated the subject, each from his own point of view. There has been a certain amount of systematic research work, directed, however, rather more to immediate practical results than to fundamentals.

A greater knowledge of the physical foundations of the process is desirable as a guide for practical development, and as a basis for confidence. If it can be demonstrated that this method of uniting steel and iron parts gives consistently good results, not inferior to the older methods, the saving in weight and labour will lead to its adoption as standard practice in lieu of the older methods of riveting, screwing and bolting.

A great deal of work has been done to ascertain the electrical conditions necessary for good work, their more or less automatic control by suitable apparatus, the adaptation of electrode material and fluxes to the particular metals to be welded, and the training of operators.

The object of this paper is to endeavour to put the results of this work on record, within the limits indicated above. The paper does not deal with carbon-arc welding, which is well established for certain manufacturing work, except to mention some physical facts which have a bearing on the iron-welding arc.

Extract from a paper presented before The Institution of Electrical Engineers.

(2) Iron-Arc Characteristics

The physics of the carbon arc as applied to lighting have been investigated by Mrs. Ayrton in her well-known work. Making allowance for the difference in the behavior of the electrode materials and the purposes to which it is applied, it is assumed that the facts established are generally true for metallic arcs, and the iron arc in particular.

The distinctive characteristic of an arc is that the current is carried by a gaseous or quasi-gaseous conductor composed of gas, vapour, very fine solid particles, or a mixture of such bodies, across a gap between terminals or electrodes which by volatilization or disintegration furnish a supply of the quasi-gaseous conductor. It is therefore essential that one or both of the electrodes shall be maintained at a temperature producing such volatilization of disintegration. The gaseous conductor behaves as one having a negative temperature coefficient: high temperature is a condition of its conductivity. The volatilization temperature is produced by the passage of the current across a relatively high surface resistance or contact resistance located at the junction of the gaseous conductor and the electrode. The electrode in the carbon arc is solid, while in the iron (and other metallic) arc it is liquid, i.e. molten. This contact resistance appears to be related to the volatilization temperature and heat of the electrode material, and to require a minimum current density for any particular electrode material. This results in a fixed voltage-drop at the contact surface where volatilization occurs. The voltage-drop along the gaseous conductor is proportional to its length, so that it appears to have a definite specific resistance. If volatilization takes place at one electrode only, as in the direct-current carbon arc, the surface resistance and voltage-drop are lower at the other electrode. In the carbon arc the temperature at the volatilization surface is higher than at the other, i.e. the positive electrode is hotter than the negative. The volatilization surface is the seat of the highest temperature in the arc.

The total voltage-drop between the electrodes is therefore the sum of three terms: two at the contact surfaces between the electrodes and the gaseous conductor, and one in that conductor. The surface voltage-drops are fixed for any particular electrode material, while that of the gaseous conductor is proportional to its length. For variations in current, the electrode material and arc length being fixed, the contact-surface areas and the cross-section of the gaseous conductor automatically vary so as to keep the current density in each constant. The resistance of the whole arc therefore varies inversely with the current passing, and the arc is unstable in itself. These statements are subject to qualifications, but are at least first approximations. The conditions of the carbon arc change suddenly at a current density which brings the positive contact surface (crater) to the edge of the electrode, producing the unstable "hissing" arc.

The numerical values of the voltage-drops and some other elements have been investigated by Mrs. Ayrton for the carbon arc in air. For arcs between metallic electrodes they are not definitely known. There is evidence that between iron electrodes of equal size, the positive electrode gas surface develops more heat than the negative. Presumably, therefore, it is similar to the carbon arc in having a higher voltage-drop at the positive electrode. It is known that the total voltage-drop across an iron arc is considerably less than that across a carbon arc, and it is probable that this lower voltage corresponds to a smaller

amount of energy consumed in the volatilization of iron compared with that required to volatilize carbon. The energy of volatilization is not a question of temperature only, different metals, as they have different "latent heats of fusion," doubtless having different "latent heats of volatilization." In the special case of carbon, volatilization takes place from the solid state, the liquid state being non-existent at ordinary pressures, so that the latent heat of a double change of state is involved. From calorimeter determinations on fuels, the heat of vaporization of carbon from the solid amorphous state is 3.231 kgm-calories per gramme, or 5 817 B.Th.U. per pound. The temperature of volatilization is about 3 600° C. The author is not aware of similar data for iron or other metals of high melting point.

In the carbon arc the volatilization temperature is reached at the positive electrode only, with a drop of about 30 volts. According to Mrs. Ayrton, the volatilized carbon is projected from the positive to the negative electrode as a "carbon mist." In air some of this carbon mist is burnt, with the production of a sheath of flame around the arc proper. Some of it—in arcs of normal length—reaches the negative electrode, on which it is deposited.

It has been rather generally assumed that a similar projection of metal takes place across an iron arc, from positive to negative, but this is not in accordance with welding practice. Deposition takes place equally well whether the electrode or the work is positive, and at least as well with alternating current as with direct current. It may be suggested that the cause of the transfer of iron is different from that in the case of carbon, but there is at present no ground for supposing that there are different processes to bring about similar results. Both cases are covered by the single statement that electrode material is transferred from the hotter to the cooler electrode. The question as to whether the transferred metal travels in the state of vapour, a fine spray, or otherwise, has been much discussed, and there are various opinions. One American investigator claims to have proved that it is in the form of drops numbering 30 000 to the ounce, which may be called a spray. That there is a definite projection is certain, for in overhead and vertical welding the iron passes against gravity from the electrode to the work. Although there is evidence that more heat is evolved at the positive electrode than at the negative, the greater mass and conductivity of the work keep the temperature below that of the electrode, even with the work positive.

The minimum pressure needed to maintain an iron arc is known to be about 15 volts. This covers the sum of the two surface resistances and that of the gaseous column. The separate values of the three terms are not known. As the welding arc is very short, it can be said that the sum of the two surface voltage-drops is something under 15 volts. This is not very different from one-third of the similar drop in a carbon arc. In a carbon-iron welding arc with a ⅛ inch diameter carbon negative, an arc length of ¼ inch and a current of 200 amperes flowing, the total arc voltage is 22. If the voltage-drop at the carbon is the same as at the negative of a carbon-carbon arc, i.e. about 9 volts, these figures indicate that the principal difference between the carbon and iron arcs is in respect to the voltage-drop at the positive electrode. Probably the conditions of a welding arc are analogous to those of a "hissing" carbon arc, in which the voltage-drop at the positive is less than in a steady arc.

From these statements it appears that there are two very definite openings for research on the welding arc, viz. (1) In what state does the iron cross the arc, and what conditions determine its transit? And (2): What is the distribution of voltage-drop in the iron arc? Another is: What are the quantitative relations of this transfer of metal to the electrical and other variables?

The practical object of research on the subject must be to determine the conditions which make the useful transfer of electrode material a maximum. "Useful transfer" covers a rather wide ground.

Like the carbon arc, the iron arc behaves as if it had a negative resistance, i. e. an increase of current across an arc of fixed length reduces the voltage-drop. It is therefore inherently unstable, and, since good welding demands the maintenance of a steady current proportioned to the size and composition of the electrode and the character of the work, all welding equipments have to include some means of adjusting the current and keeping it within limits during the operation.

The figure of 15 volts for minimum welding-arc voltage-drop is derived from tests made with direct current, bare iron electrodes and automatic feed of the electrode. With hand operation the voltage is always higher, i.e. from 22 to 25 volts. This is for the mechanical reason that the hand cannot maintain steadily the very short arc, about ⅛ inch, corresponding to the minimum voltage, but has to work with a minimum length of about ⅛ inch. Flux-covered electrodes appear to permit of a somewhat greater working length and voltage, thus rendering the manipulation easier. It is rather difficult to measure the true arc length with flux-covered electrodes, as the metal "cups" a little above the edge of the covering.

If the arc is lengthened much beyond the figures given, good welding is impossible. The iron passing across the arc burns to oxide, absorbs nitrogen, and the deposit is contaminated, permeated with blow-holes, mechanically weak, and may fail to unite with the metal of the work. The arc length at which this defect commences is variously stated as that corresponding to from 27 to 30 volts. It is probably rather higher for covered electrodes and for alternating current.

The fact that good welding can be done only within a rather narrow range of arc length and voltage imposes another condition on welding equipments, i.e. they should not permit of an arc voltage exceeding the maximum for the deposit of good metal. If an arc is drawn beyond this it should be extinguished.

This condition has to be reconciled with the fact that the open-circuit voltage must be in considerable excess of the arc voltage to provide for the voltage-drop in the steadying resistance or reactance required to make the circuit reasonably stable, and also to permit the arc to be struck readily.

Facility of striking the arc is an important element in the time and labour cost of arc welding. Whilst a sufficient open-circuit voltage is necessary, if the circuit conditions permit the passage of a very large current at the moment of contact, the electrode may stick or "freeze" to the work, making a sort of resistance weld, which is not wanted. As the longest electrode which can be conveniently used is consumed in a run of 1 to 3 minutes, such interruptions add materially to the time spent in changing the electrodes.

(3) Direct-current Versus Alternating-current Welding

Good welding can be done with both direct and alternating current. There are preferences, and as direct current had the start more operators and others were in favour of direct current than of alternating current. The best electrical conditions are slightly different, and there are differences in the actual manipulation, but experience shows that operators who have been accustomed to one readily adapt themselves to the other. It is also the case that flux-covered electrodes are essential for alternating current, apparently because the lagging effect of the flux and slag maintains the necessary temperature during the periodical current reversals. The only real difference is that the striking of the arc is rather more difficult with alternating current.

A higher open-circuit voltage is required with alternating current. With direct current an arc can be maintained with a minimum of 45 volts (open circuit), but 60 volts is much easier to work with, and can be taken as the practical figure. A higher voltage permits of an excessive arc length and a poor quality of deposit.

With alternating current the open-circuit voltage should be from 75 to 90 volts. The difference between the arc voltage and the open-circuit voltage has, in the case of direct current, to be taken up in a steadying resistance, while a reactance is used with alternating current. There is therefore not so much difference in the steadying losses as might be supposed. It may, indeed, be possible to make alternating current more efficient in this respect than direct current, as will appear later in the descriptions of some of the equipments available. The alternating-current arc

has a lagging power factor, but the magnitude of this depends a good deal upon the steadying and regulating equipment, and it need not be lower than that of the average works induction motor at full load.

Where it is desired to make use of a general public supply for welding, direct current imposes the necessity for the use of some form of motor-generator. The pressure of the public supply mains is generally 200 volts or more. To take from such mains welding currents of from 30 to 200 amperes per operator is not practicable or economical, for, in addition to the waste, the large bulk and high cost of the resistances, the open-circuit voltage is far too high. Further, public supplies generally have an earthed neutral, and the earthing of the work welded, which is often unavoidable and always advisable, cannot be permitted by the supply authorities, who also will not be pleased by the intermittent peak of hundreds of amperes. With an alternating-current supply the voltage reduction requires only a transformer.

(4) Electrodes

The first iron-arc welding was done with bare-wire electrodes. These are still widely used, and for some kinds of work where strength is not material the welds made may be satisfactory. With direct current operating on mild steel and wrought iron, flux-covered electrodes provide better results. For welding cast iron, high-carbon steels and alloy steels, and generally with alternating-current welding, flux-covered electrodes are necessary.

With bare electrodes there is oxidation of the electrode itself beyond the arc, and of the weld metal and work whilst they are hot. A suitable flux covering protects the electrode beyond the arc, forms a protective slag on the deposited metal and work, and reduces the access of air to the arc itself. The arc length is somewhat greater and the current steadier, probably because the current is confined to the electrode end, and it cannot reach the outside. Manipulation is easier, as the arc can be struck on hot slag without any liability of the electrode to "freeze on." The deposit from a covered electrode on to a flat surface spreads more than that from a bare electrode, owing to the fluxing action of the slag, thus making a wider union and a neater finish.

Coated electrodes are essential for use with alternating current, probably because the coating and slag conserve the temperature during the periodic variations of the current.

The flux coating plays a very important part in welding high-carbon steels and alloy steels and cast iron, where it is necessary to obtain weld metal approximating in composition and structure to those materials. The electrode metal passing through the arc is considerably altered in composition; for example, carbon and manganese are burnt, or rather oxidized, by the reducing influence of the arc. The flux coating reduces the amount of this change, and may impart or restore the desired constitutents. Whether this action takes place in the arc, or between the flux and the deposited metal, or partly in each, cannot be said. In the manufacture of steel the reactions between the metal and the flux in the furnace are essential parts of the process, and the composition of the flux is carefully adapted to the product desired. In arc welding, however, the time available for reaction is very short. This short time, the high temperature and the fine division of the electrode metal passing through the arc, are conditions widely different from those of the steel furnace, and a great deal of experiment has consequently been needed to arrive at the proper fluxes for different materials. In matching any particular steel the composition of the electrode and the flux co-operate. The electrode metal does not, as a rule, match that of the material. The work of producing electrode and flux combinations which will make good welds in different materials has met with great success. It has necessarily been done empirically, as no general principles can yet be formulated.

In the result, cast iron, manganese steel, nickel steel, stainless steel and other special alloy steels are all successfully arc-welded by the use of appropriate electrodes and fluxes.

For most purposes a flux coating of a basic nature is desirable, but in some cases it is of an acid description. An aluminium wire or tape is sometimes included, and nickel plating is also used. Both these metallic additions tend, in different ways, to reduce oxidation of the electrode metal, and may also have other effects.

The metallurgical and chemical actions of the coating and the flux formed by it have to be reconciled with other requirements. The coating must fuse at a slightly higher temperature than the metal, while the slag formed must be very liquid and light so that it will rise to the surface before the metal solidifies and will spread over the hot weld and so protect it from the air. The flux should dissolve or reduce the iron and other oxides. The glassy skin of cooled slag should be easily removed from the welded surface by brushing or light hammer chipping, and the coating must be sufficiently tough and adherent to the electrode to withstand transport and handling. In working, the coating must fuse evenly without flaking and must keep level with the end of the electrode. There is usually a little "cupping," i.e. the electrode end is a trifle inside the fused rim of coating. Deep cupping is, however, objectionable, as a projecting rim of fused coating interferes with the arc striking and misleads the operator in respect to the length of arc. Whilst hot the slag is a semi-conductor and the arc may be struck on it without any risk of the electrode sticking.

Intermediate between bare and coated electrodes are dipped electrodes, i.e. electrodes dipped into a "slurry" of a basic nature. This coating has some protective influence on the electrode as against oxidation, and reduces spluttering and current fluctuations as compared with bare electrodes. It is not a substitute for flux coating.

(5) Current Density

The current required for welding depends mainly upon the thickness and mass of the parts to be joined. It may be said roughly that the dimensions of the work determine the current, and the current determines the size of the electrode. For each gauge of electrode there is some maximum manageable current. If this maximum is exceeded the electrode fuses far beyond the arc, large portions drop, the current fluctuations are wild and the arc is turbulent and unmanageable. For coated electrodes the maximum currents range from 60 amperes for No. 14 gauge to 200 amperes for No. 4 gauge. The current densities thus vary from about 12 000 amperes per square inch for the smaller, down to about 5 000 amperes per square inch for the larger. Somewhat higher current densities can be used with bare electrodes. The American practice, which is chiefly with bare electrodes, is to use 10 000 to 12 000 amperes per square inch.

An electrode is capable of welding properly with two-thirds or less of the maximum current, so that six gauges, i.e. Nos. 4, 6, 8, 10, 12 and 14, cover a long range of work. A current of 200 amperes and a No. 4 electrode are about the manageable maxima for hand welding. Whether automatic welding will permit of larger values has not yet been determined. Automatic arc welding is hardly beyond the experimental stage in commercial service.

The statement made above (that the current is determined by the dimensions of the work) is subject to some qualifications. For example, in making a butt weld between two plates, say ¼ inch thick, the edges will be beveled, forming a V of an angle of about 60° when approximated. The first run of welding must be done with a small electrode, say No. 8, in order to get the electrode to the bottom of the V, which must be first filled. A second run is then made over the first with a larger electrode, and a third may be necessary. As the area or width increases, the electrode size and current required increase.

Mr. H. M. Hobart, who has taken a leading part in electric arc-welding development and research in the United States, says that the largest current which can be used makes the soundest welds. Too large a current for the thickness and mass of the work burns holes in it.

Welding thin sheet is practicable but has not been much developed, possibly because oxy-acetylene and resistance welding have a firm hold on this class of work. Recent experiments, however, promise good results, and thin sheet arc welding may prove commercially valuable.

(*To be continued*)

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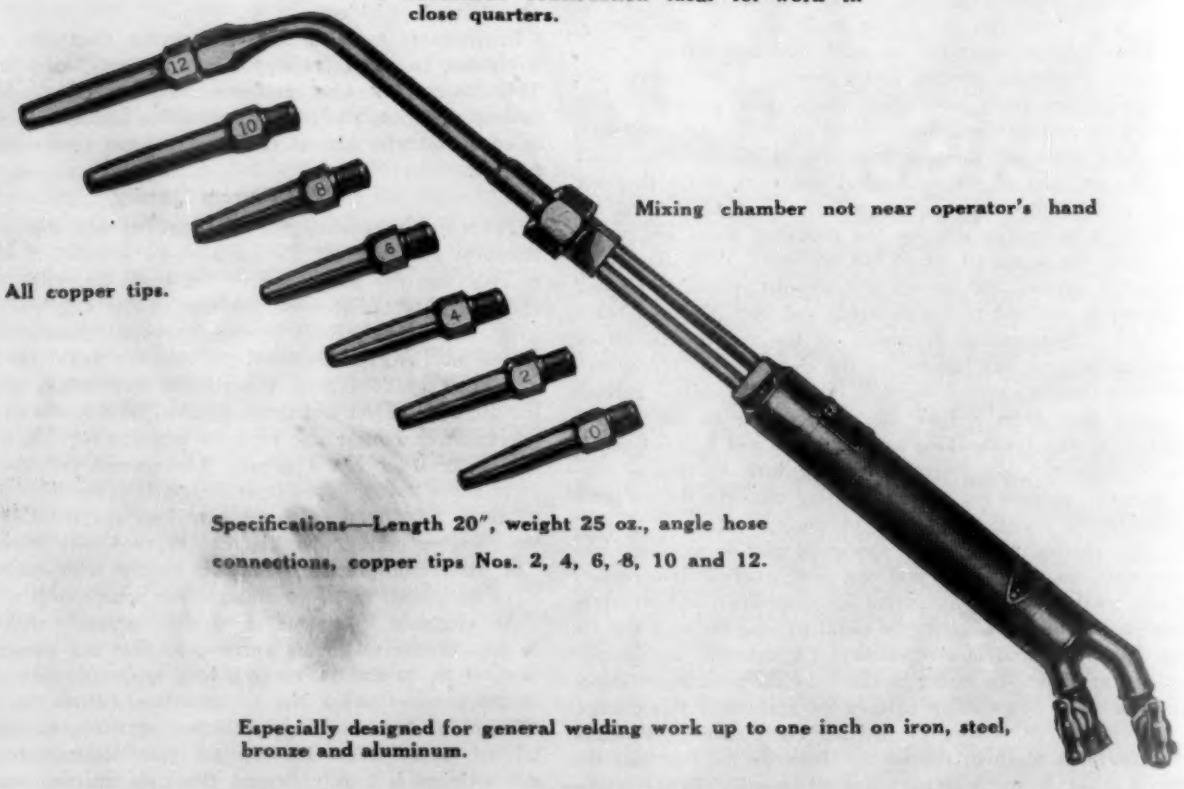

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Discarded Tubes Used for Pipe Lines

The Story of Savings Effected When Welding Torch Recovered Material from Scrap Piles

ALMOST simultaneously from four or five different sections of the country have come reports of instances where used boiler tubing has been reclaimed from the scrap pile by oxy-acetylene welding and cutting and has been put into service again in the form of welded pipe lines carrying oil, gas, steam for heating and other materials. In several cases where the reclamation of boiler tubing is carried on by scrap dealers quite a profitable side line is opened up, and in the other cases where industrial plants have reclaimed their own boiler tubing or that bought from others, the operation has enabled them to install their pipe lines at a very much lower cost than would have been possible had new pipe been purchased.

In one case a large scrap dealer in Missouri has reclaimed large quantities of scrapped 4 in. boiler tubing which is now being installed as part of a 28-mile welded gas line. The gas company using this reclaimed pipe is finding it just as satisfactory as new material and much less expensive because the first cost is considerably lower, since the material is reclaimed from scrap and also because of a large saving in freight since the reclaimed tubing is purchased locally. In a parallel case another pipe line company is installing an 8-mile 4-in. welded gas line made from reclaimed boiler tubing which they salvaged themselves from out-of-service boilers which were purchased as scrap. In this case, after the tubes are removed from the boilers the operators reduce the remainder of the boiler to charging box size with the oxy-acetylene cutting blowpipe and this material is resold as melting scrap.

In another instance a job welder in California has found it profitable to purchase second-hand boiler tubing from the various scrap dealers in the section in which he is located. He buys this material practically for its melting scrap value and after defects such as pits have been repaired and two or three tubes welded together to form a section of pipe of approximately standard length it is resold by him to the trade, principally for installation in welded pipe lines. This particular job welder also specializes in the installation of welded water lines throughout the territory in which he operates. Nearly all of the pipe used in this work is the reclaimed material which his own men salvage from scrapped boilers.

In every case the pipe lines made of this reclaimed boiler tubing give service just as satisfactory as could be obtained through the use of new pipe. This is to be expected since the only difference between a 40-ft. length of standard pipe and the 40-ft. length of pipe composed of salvaged boiler tubing is in the several welded joints which appear in the latter. These welded joints, which are properly made, since they are made by operators who do little else than pipe work and who understand thoroughly the principles of proper pipe welding practices, give just as long and as satisfactory service as unwelded portions of the pipe. It is generally conceded that in a pipe line where the joints are made by oxy-acetylene welding that the welded joint is the strongest part of the line, since the weld metal is always of better quality than the base metal in the pipe and because the weld is unusually reinforced to a slight degree. Hence, if the pipe is subjected to a stress while in service severe enough to cause failure, the failure will be in the wall of the original pipe and not in the welded joint.

Although the ends to be accomplished are the same in every case, the methods of preparing scrapped boiler tubing for use in pipe lines vary with the different organizations doing this work. In general the operations consist of cutting off the split or corroded ends, straightening such tubing as may be bent or deformed, building up pitted places of the pipe damaged by rust holes and welding the comparatively short lengths of boiler tubing into 30 ft. or 40 ft. sections for convenient and economical handling in the field.

In some instances where large quantities of this tubing are being reclaimed the operation of cutting the damaged ends of the tubing has been highly standardized by the use of specially built tables and racks, and guides for both the pipe and the cutting blowpipe. In one case a scrap metal dealer doing a considerable amount of this work has built a cutting table from 2x4-in. lumber. This is so arranged that the pipe fits down into a 90 deg. angle section, thus lining up the pipe no matter what diameter it happens to be.

A movable guide is arranged at the end of the table opposite the end at which the cutting takes place. This guide is so fixed that it can be moved forward and backward to fit tubing of different lengths and its particular object is to prevent the pipe from "creeping" while it is being cut and to enable the operator to make his cut squarely across the end of the tubing.

The cutting blowpipe is held in a rack at the other end of the table and is operated by the cutter just as though he were cutting the pipe ends by hand with the exception that the blowpipe is held fixed in one position. To complete the cut around the circumference of the pipe, the pipe is turned by a helper who acts under the direction of the man operating the blowpipe. When it is desired to cut the pipe ends so that they will be beveled for welding, all that it is necessary to do is to arrange the blowpipe holder so that the head of the blowpipe is inclined at an angle to the wall of the pipe.

In another shop a 20-ft. length of angle iron is used in place of the cutting table mentioned above. This angle is set so that when the pipe is being cut it will rest and guide down in the angle. Movable guides are also used in this case to insure square and even cuts on the pipe ends. The use of angle iron for this work also serves as a guide in straightening deformed lengths of pipe, which may be heated with the welding blowpipe in the bent places and straightened by force applied to the heated section.

When the damaged ends have been removed from the pipe various other defects which may be found are corrected by welding. Pitted sections are welded, or if the portion of the pipe damaged in this way is too extensive for practicable handling by welding the individual defects, a section may be cut out of the pipe and a new piece welded in. Where excessively rusted places are found the rust may be removed by heating with the oxy-acetylene welding blowpipe and brushing with a wire brush and then the section built up, if necessary, by welding.

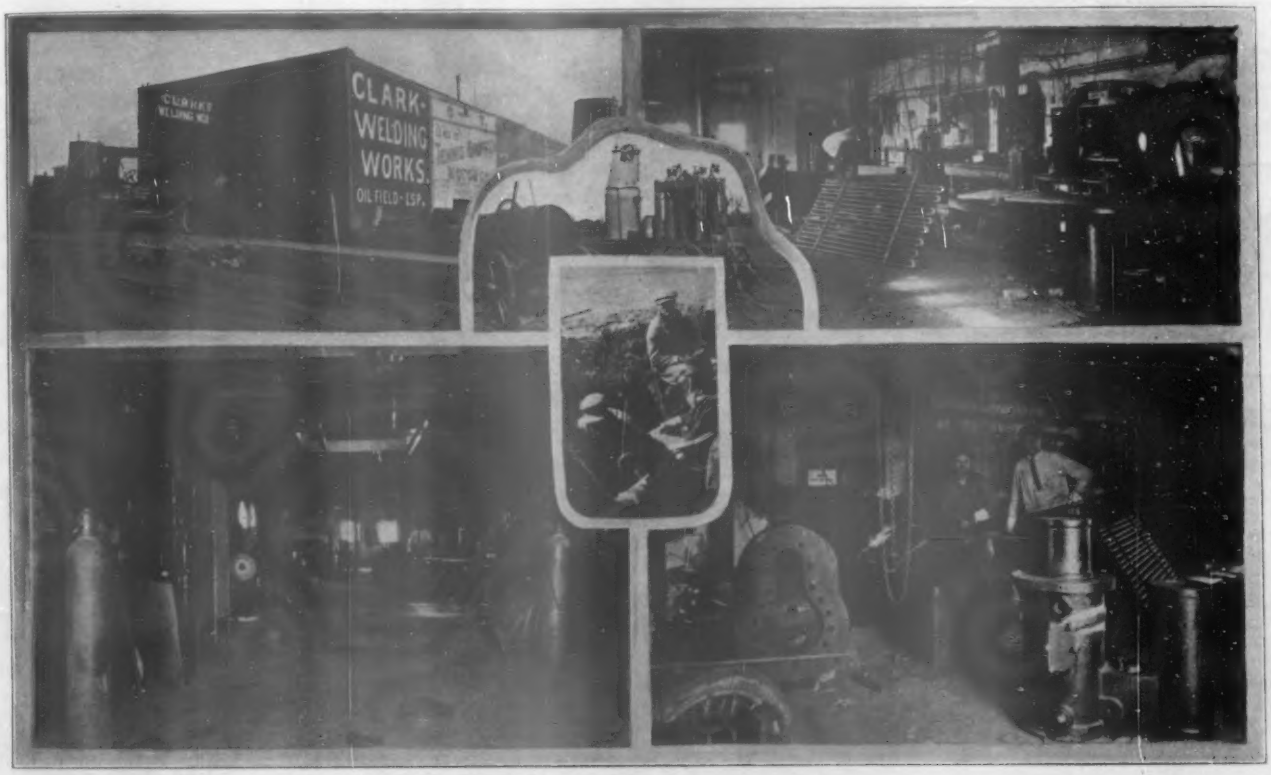
When the welded boiler tubing is sent into the field for installation it is handled in just the same way that new lengths of standard pipe would be handled. The sections are welded together as is customary practice in most pipe line welding, until the welded section reaches a length of from 800 to 1,000 ft. When a number of sections of this length are ready they are dropped into the trench and are joined together by a welding crew working in what is known as a "bell hole," which enables the operator to weld the entire circumference of the pipe joint without turning the pipe.

Reports of work of this kind from four or five scattered sections of the country indicate that advantage is being taken of the savings to be made through the reclamation of used boiler tubing generally in the trades which purchase boilers as scrap and which use welded pipe. However, there is undoubtedly a great quantity of used boiler tubing which might be salvaged profitably that is being cut up into scrap sizes and sold for no more useful purpose than to be remelted. Much of this can be conveniently handled in ways outlined here if the value of this

reclamation opportunity is appreciated. This represents an excellent way for an energetic scrap metal dealer to increase the revenue derived from boilers he purchases as scrap, or for a welding shop to utilize idle time.—*Oxy-Acetylene Tips.*

OKLAHOMA BOASTS ONE OF THE BEST EQUIPPED SHOPS IN AMERICA

The Clark's Welding Works, owned and operated by Fred Clark at Drumright, Oklahoma, is one of the best equipped welding shops this side of the Mississippi. It is also considered one of the best shops in the entire country. It is the boast of the proprietors that practically no welding problems come up but what can be taken care of. The usual run of work includes the heaviest kind of welding from oil fields. The Eureka Tool Company, of Drumright, is one of the best customers this shop has. Following is a list of things welded daily: Boiler welding, special tanks, header coils, engine heads, bed plates, castings of all kinds, low carbon steel, under-reamers, shoes, and welding bailer bottoms. Both the oxy acetylene and electric processes are used.



Views of Clark's Welding Works, Drumright, Oklahoma, Showing Various Jobs in Progress. The Inserts Illustrate the Portable Outfit Used on Pipe.

Fred Clark, the manager of this progressive shop was formerly head welder for the Wabash Railroad at Decatur, Ill. He went to the Drumright Oil Fields in 1914 and has been in the welding game ever since.

The four large photographs in the group show the shop of the Clark Welding Works and the three interior views of various welding jobs in progress. The smaller pictures illustrate the portable outfit used in pipe line welding and a welding crew making a pipe joint.

GAS MANUFACTURERS TO CO-OPERATE WITH WELDING SCHOOLS.

The Gas Products Association, headquarters at 140 S. Dearborn Street, Chicago, Illinois, recently appointed an educational committee to co-operate with trade and technical schools all over the country in supplying a practical and standard course in welding procedure. The users of oxy-acetylene welding equipment have never been thoroughly satisfied with the work done by welding school graduates, and at the same time the application for the welding processes has been extended to so many new fields that the demand for skilled operators is constantly increasing. It is thought that by making a thorough investigation of the needs of the industry and then making recommendations to welding school instructors, the instruction programs can be revised and standardized so as to more fully meet the requirements of the employers. The plan has been already submitted to some schools and has met with their enthusiastic response, so it is felt that the instructors are honestly desirous of giving the students such training as will guarantee them the very best earning power.

The Committee will endeavor to build up a list of accredited schools which are known to give a standard instruction, and whose students can be depended upon to qualify as satisfactory welding operators. It is proposed to make this educational movement effective all over the country, and since the members of Association have gas and apparatus manufacturing plants in practically all of the important industrial centers of the United States, it is quite likely that this plan can be carried through without difficulty.

A careful survey has been in progress for sometime of the present condition and affairs with respect to training operators in schools, and additional data is being collected so that the Committee will eventually know what work is being done in every school in the country where welding is being taught. A standard course of instruction has been adopted covering the requirements which will have to be met before schools can be placed upon an accredited list. The schools which meet these requirements will be given assistance in the conduct of their courses and will receive a considerable amount of co-operation from manufacturers of gas and apparatus, which will result in a marked reduction in the cost of conducting a welding course. It is also planned to advertise these schools collectively so that prospective students may be able to select the school nearest him which provides the best kind of training for this trade.

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VOLUME 8 NOVEMBER, 1923 NUMBER 11

CONTENTS

Accurate Cutting on Cast Iron..... 19
Arc Welding Apparatus..... 23
Discarded Tubes Used for Pipe Lines..... 28
Gas Manufacturers to Co-operate with Welding Schools..... 29
Editorials..... 30
Arc Welded Storage Tanks..... 32
Hints for the Welder..... 36
Pressure Welding Competition..... 42
Acetylene Welding Used in Manufacture of Doble Steam Car..... 46
News of the Welding Trade..... 46
International Acetylene Association Meets..... 47
Current Welding Literature..... 48

The Cost of Welding

IT IS as difficult to make an accurate general estimate of the cost of doing a welding job as it is to make a perfectly safe statement as to which process is best for a particular job. Welding costs must be figured on the basis of the cost of operation in a particular shop. The prices of equipment and supplies, maintenance costs, labor costs, etc., are not well enough standardized to furnish a basis for setting a standard cost figure for any welding operations. The cost of doing a particular job in a railroad shop may be considerably different from the cost of doing the same job in a factory and automobile repair shop, or a job welding shop. Before using somebody else's cost figures, be sure that you understand thoroughly the conditions under which these figures were compiled and that you are able to make an accurate comparison of the small items which go to make up the total.

Standards for Training

THE principal handicap imposed upon the welder who has secured his training in a welding school is that nobody knows exactly what sort of training he has received. Each school has its own system and method of instruction, and these methods are subject to change when the personnel changes. The art of welding is also such a new one that there has been no time to develop a regular course of apprenticeship as in some of the other trades. It will be very helpful to the industry and to the schools which are teaching welding, if a standard program of instruction can be established throughout the United States. It will then be known approximately how much the welder knows who has taken a school course. The employer who hires new welders under such circumstances will be better able to develop such men into efficient operators for his own work.

Progress in Tank Welding

FOLLOWING the success of a large construction company in welding the roofs and bottoms of mammoth oil storage tanks comes the report that a leading oil concern has standardized on welding for the bottoms and roofs of its tanks in the eighty thousand barrel class. It is evident enough that the existing prejudice in favor of riveted construction is being gradually worn away, and that in view of the successful construction of all welded tanks and gas holders of large capacity, further progress may be confidently expected. There are a few "bugs" yet to be removed. The handling of material is an important one. This may well be made the subject of separate research and also a point to be watched by salesmen and service men who supply equipment for these jobs, so that devices which help to speed up the work by enabling a maximum number of welders to work at once may be made common knowledge.

Make It a Profitable Trade

EVERY time an apparatus salesman tells a purchaser that welding can be taught to some workman in the plant in a few days' time by a demonstrator, or service man, he deals the entire industry a vicious blow. No employer will recognize a trade so easily learned as deserving of a good wage, and no really good workman will take up a trade which does not pay well. To help the advancement of the art, it is better to recommend the hiring of a skilled operator or a well trained apprentice, and pay a rate commensurate with both skilled and conscientious workmanship. The right gospel to preach today is that low-priced help is a serious mistake, wasteful and expensive. The welding processes are at their best as money-savers when applied by expert operators. The payment of better wages to welders should be encouraged so that the trade will attract men who are capable of producing the best of results.

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Investigations over a period of years by the United States Bureau of Mines show conclusively that not less than $200,000,000 worth of gasoline will evaporate from the crude and gasoline produced and handled in this country during 1923. For the same period, a rough figure for loss by fire in the petroleum industry in the United States would be $20,000,000. Neither of these figures are small, but the evaporation cost is ten times the fire loss. An oil company can insure against fire but not against evaporation loss. Fire may happen, but evaporation at present is sure.

The Wiggins Floating Roof eliminates practically all of the evaporation that takes place in a tank. It also eliminates most

Inspecting the Finished Tank.

of the fire hazard. The main body of the roof is the float which consists of a blanket of steel 3/16 of an inch thick and one foot less in diameter than the tank. The vertical rim of the shell is about 17 inches high, also of 3/16-inch plate. The entire float is preferably electric welded. Reference to the diagram showing the construction of the tank and roof will indicate the locations of many of the welds. Where seam welds occurred the plates were lap-welded with a lap of 1 inch. After being first temporarily and then permanently tacked with a space of one foot, the final weld was completed. The provision made to take care of rain fall was to divide the upper surface of the roof into a number of pockets 8 to 10 inches high and of balanced area. This is accomplished by welding vertical vanes to the roofing. The vanes, flanges, pipe fittings; in fact, everything including the roof itself are electric welded.

The rain drainage system for this roof consists of: (1) A number of pipes lying on top of the roofing which drain each pocket of the main control system and which are manifolded to a central drain; (2) Either a siphon and well or a pantographic arrangement of pipes. The former conducts the water into the bottom of the tank. The latter leads the water to the outside of the tank. The siphon has two main advantages over the pantograph; namely it has no moving parts to get leaky and it c be removed and repaired. In the case of the siphon, the ra water is drained from the bottom of the tank periodically throu the regular water draw-off valve. The pantograph has the a vantage of storage that stands for long periods, that the ra is conducted outside of the tank. Working tanks, however, su as at refineries or on pipe lines have daily or sometimes hour gauges. It is very little trouble then in most cases to drain th water from the bottom of the tank after each rain. Either system, or both may be installed, but the siphon system is recommended, especially for working tanks. The only function of th weld in the center of the bottom of the tank is to receive th siphon, which is about 10 feet long. There is a drain attached

Roof, Flanges and Vanes All Welded.

to a point near the bottom of the well for drawing the water off the roof when the tank is nearly empty.

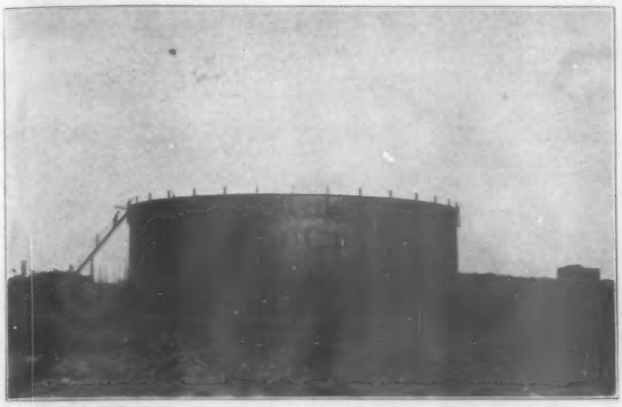
The "seal" is the means of joining the roof to the shell of the tank in a sliding contact. It consists of a "shoe," a "horizontal," a "flexible gas-tight fireproof material," a "spring pressed plunger," and "curved hangers." The seal is made in sections, flexibly joined to the top of the rim of the roof to each other. The "shoe" having the same curvature as the tank, and leveled to ride over plates and rivets affords close contact with the shell

Burning Gasoline Poured On Center of Roof.

of the tank for a vertical distance about 24 inches. The "horizontal" is welded to the "shoe" and the whole is supported by practically frictionless hangers which are so disposed as to cause the weight of the seal to throw itself positively against the tank. As the "shoe" comes closer to the roof than its normal distance,

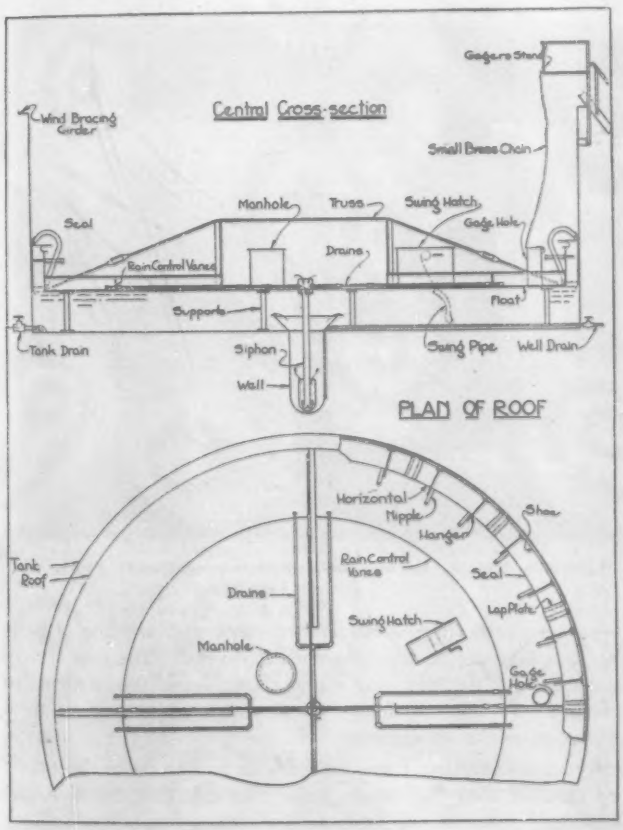
it engages a spring-pressed plunger carried by a horizontal nipple. This plunger aids gravity in pushing the "seal" against the shell of the tank. This construction with the flexible material provided between the seal and the rim of the float practically gives the roof the effect of a flexible steel shell, which is at all times kept in close contact with the shell of the tank and follows any irregularities.

The tank used in making the fire test contained about 3 feet of water. On top of the water there was an average depth of



55,000 Barrel Tank Equipped With Wiggins' Floating Roof.

gasoline of 2½ to 3 inches. The steel floating roof actually floated on the surface of the gasoline. Reference to the diagram of the work will indicate that there is a gas-tight space between the vertical rim and the floating roof and the shoe which presses



Roof Plan of New Type Tank.

against the tank shell. This is the only air space, and its size is in marked contrast with the great volume of evaporation encouraging air in the ordinary tank with the canopy roof.

In the tests made, fire was applied to the aperture between the shoe and shell over the entire circumference without fire resulting. Then fire was applied by means of the blow torch to one of the four, three-inch vents which had been placed in the horizontal. This ignited the the mixture between the vertical rim and the shoe. Smoke and flame belched forth from the vents, but there was no permanent fire.

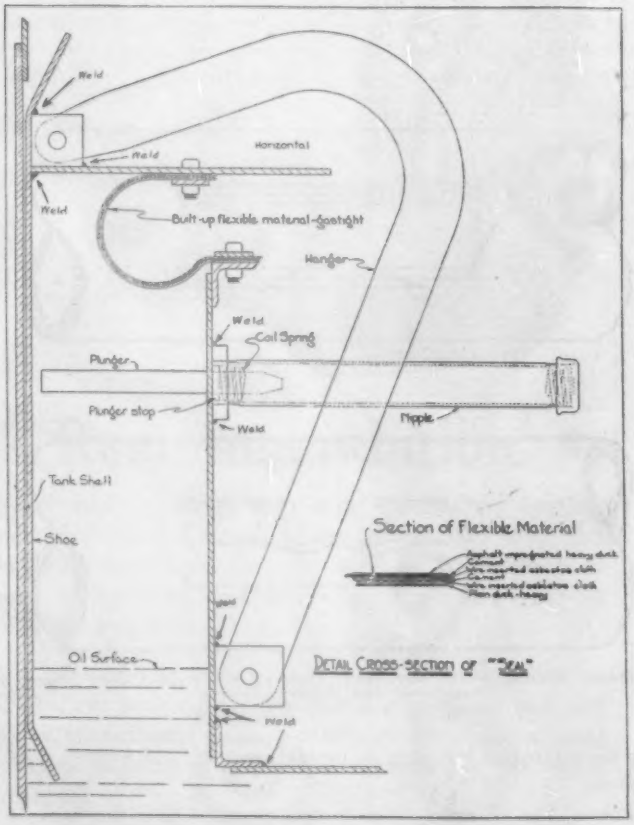
This test proved that fire resulting from a lightning flash or by the presence of flame from any source would only be momentary and would cause no damage.

A piece of burning waste dropped down the vent caused a similar result.

When a fire was built in the center of the tank by igniting a bucket of gasoline which had been poured on the roof, the gasoline in the tank was not ignited, although the fire on the roof lasted five minutes and was sufficient to cause flames to shoot up 8 feet or more.

Then gasoline was pourned around the horizontal and around the edge of the float. When this was ignited it burned for eight minutes but did not ignite the gasoline in the tank.

An extra test was made in which gasoline was pourned down between the aperture between the roof and shell. When ignited, this bunrned and in an instant or two ignited the mixture between the vertical rim and shoe. This ignition under the horizontal was only momentary. The gasoline which had been poured between the operture continued to burn for five minutes or so, but did not ignite the contents of the tank.



Seal Used on Floating Roof.

A demonstration of a Foamite hand extinguisher was made, which showed that one man could entirely close the opening between tank shell and roof in about one and one-half minutes.

The tests were witnessed by a large number of prominent members of the oil industry. Everyone present was impressed by the demonstrations of the marked fire-protective qualities of the roof. It must be remembered that there were a thousand gallons of gasoline under the roof. The amount was measured by gauging before the tests and a sample taken from the tank was burned before the guests to show that the content was actually gasoline.

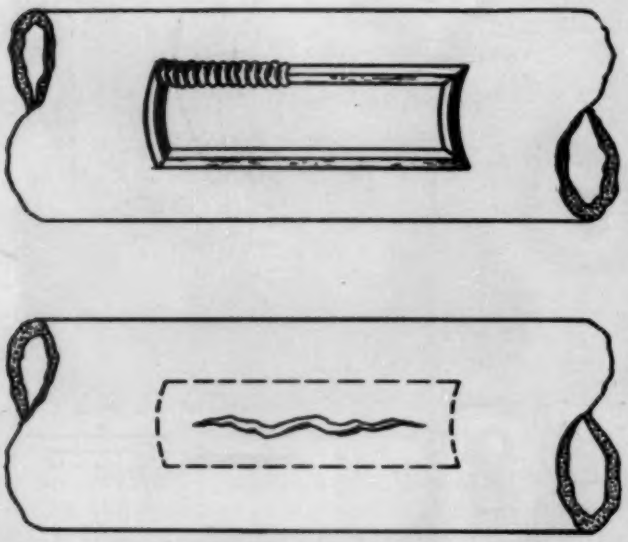
The great value in this roof is the elimination of evaporation. Tests made on this roof show that it practically eliminates loss.

When we consider that the evaporation loss costs the oil industry about $200,000,000 a year, it is evident that the value of the Wiggins Floating Roof to the oil business can hardly be over estimated. The annual loss by fire is also an important waste which use of this roof seems likely to reduce.

It has been pointed out that in the construction of this roof, the manufacturers recommend that it be electric welded throughout, although they are prepared to furnish riveted construction when it is specified by the customer. The Chicago Bridge & Iron Works have been responsible for the development of some of the largest tank welding projects, and are thoroughly convinced of the advantages of welded construction. The inventor of the roof described in this article goes so far as to say that welding is one of the things which makes this new type of roof possible. It is certainly an encouraging thing to the men interested in welding to know that in this new development of tank construction the welding process booms up as an important factor right at the start. Further study on the application of the process to tank construction is certain to result in extending the field for the all-welded tank.

REPAIRING A RUPTURED PIPE BY OXY-ACETYLENE WELDING

A ruptured or broken pipe in the power systems of an industrial plant is often the cause of a shutdown and concurrent serious production delays. Hence it is advisable to be prepared for such emergencies by understanding how to handle such a job and having the equipment necessary to its execution at hand when it does happen.



Above: Section to be Removed. Below: Patch in Place, Edges Chamfered, and Welding Begun.

Forces, like so many other things, always follow the lines of least resistance so that when a break occurs at a certain point in a pipe it is usually feasible to assume that the pipe was weakest at that particular point. In repairing the break by oxy-acetylene welding (no other method is considered since this is usually the most practical), it is well to keep in mind that the metal immediately in the vicinity of the break is probably weak also, and for this reason it is best to remove it for a short distance back from the break.

If the break is a longitudinal rupture, as is usually the case, it may be repaired as follows: With an oxy-acetylene cutting blowpipe cut away the ruptured and weakened metal leaving a rctangular hole in the pipe as indicated by dotted line in first sketch. Then a rectangular patch of the same thickness and form may be obtained by cutting it from a stock or scrap length of the same size and class of pipe, or it may be readily formed from a piece of sheet steel of the same thickness as the pipe wall. If this thickness is ⅛ inch or more the edges of both the hole and the patch should be beveled to a 45 degree angle with the cutting blowpipe so that when the piece is inserted a 90 degree vee will be formed, thus permitting the welder to obtain full penetration of the joint when he butt welds the patch in place. (A piece of rod welded to the patch will serve as a handle by which it can be held in place during welding and is readily cut off with the blowpipe after the welding is completed.) This type of repair can be fully completed in an hour or two, can be made at very small expense, and has the decided advantage of being permanent.

LOUISVILLE HAS BUSY WELDING SCHOOL

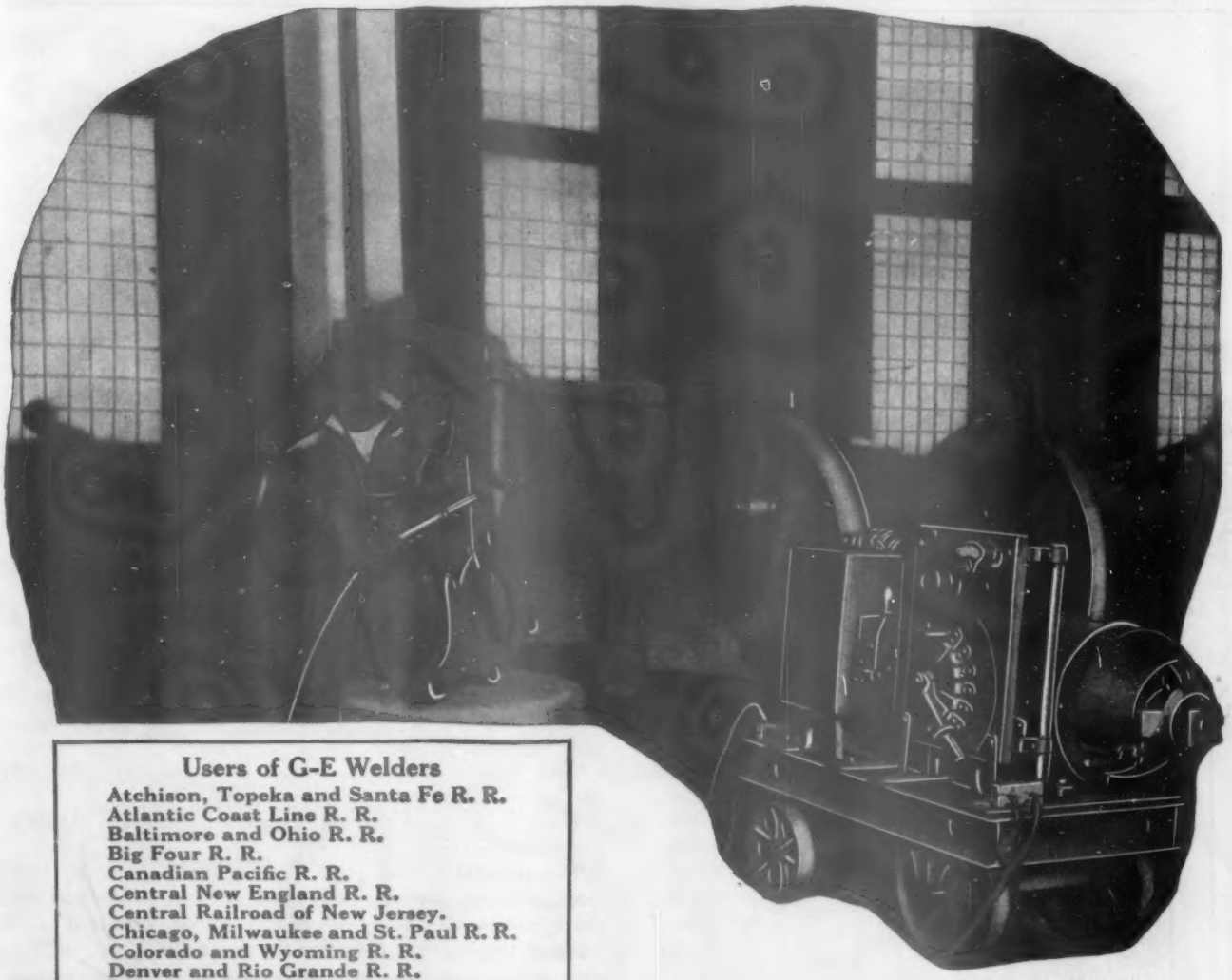
The Louisville Institute of Technology—the name by which the Louisville Y. M. C. A. Schools are known—is performing a real service in the automotive and autogenous welding field of Kentucky and the South by conducting an automobile and welding school which supplies the industry with a large number of trained men for maintenance and repair of automobiles, trucks and tractors and for all classes of oxy-acetylene welding.

Both the auto and welding schools are fully equipped with the most modern facilities. Several standard makes of automobiles are available for study on the floor of the auto school. There are ten complete acetylene welding stations in the welding department to which the gases are supplied through a piping system. Both departments are in charge of experienced and capable men and the courses are so planned as to give the students as much practical work as possible and at the same time, make them familiar with the underlying reasons and theories.

Louisville Welding School's Display Shown at County Fairs.

Separate courses are given in both auto and welding departments, but they can be taken together if desired. The cost is very reasonable and the day and night classes give the student an opportunity to take advantage of thorough instruction in these branches at minimum expense.

In order to advertise these departments and to make the public more familiar with the value of their work in this direction, the Louisville Y. M. C. A. Schools took space at several recent county fairs in Kentucky, as well as at the Kentucky State Fair in Louisville, where they displayed some of the equipment used in the schools and gave practical demonstrations of welding and cutting by the oxy-acetylene process. A representative of the Kentucky Oxygen-Hydrogen Company was in charge of this part of the work. This method of publicity proved to be so highly successful that both the auto and welding schools now have waiting lists.



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Grand Trunk R. R.
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International and Great Northern R. R.
Lehigh Valley R. R.
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A Recommendation

Worth-while savings are being effected by leading railroads thru the successful use of G-E Welders. The Santa Fe finds G-E Electric Welding Equipment so much to its liking that this railroad is using over 80 G-E Welding Sets.

G-E engineers have thoroughly studied the application of electric welding to the various needs of railroad shops, roundhouses, etc.—and have developed several types of welding equipment to accomplish the work required.

For complete welding service the General Electric Company offers single-operator and multi-operator units, portable and stationary, also semi-automatic and full automatic welders. Ask the nearest G-E Sales Office for complete information.

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43B-196

Hints for the Welder

When you finish an interesting piece of work, can you set down on paper the manner in which you went about the job, how you prepared the work and how the job was done? Have you learned some little stunt every welder ought to know? Contributions to this department are paid for. Write it down any old way – I'll polish it up. Make a rough pencil sketch and our draughtsman will fix it up fine. Line drawings are more practical than photographs. Do it today – the men on the firing line are waiting. L. B. Mackenzie, Editor.

BRAZING NICKEL-PLATED PIPE

By George Reed

The other day the "Boss" handed me about 12 inches of ¾-inch polished nickel-plated brass pipe with both ends plain. He told me to put an inch of standard pipe thread on one end and braze over the other end, giving it a ball effect, as per Fig. 1, without damaging the plating.

Now to thread one end without showing any vise marks was not very difficult. I simply split a short piece of old rubber hose

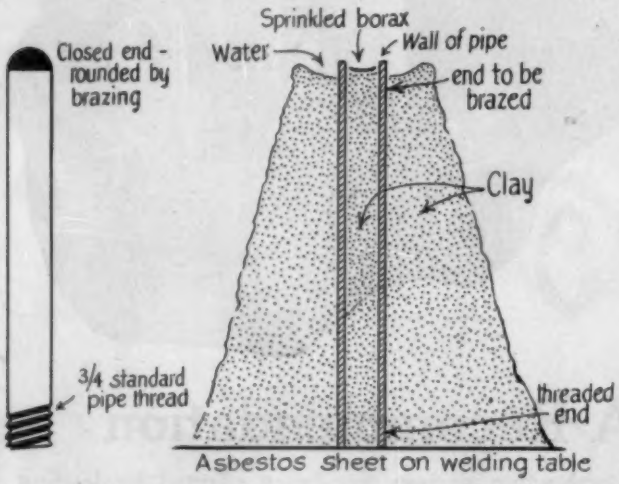


Fig. 1

Fig. 2

one side and after cleaning it inside slid my nickel-plated brass pipe inside it and had no further trouble, but to braze the other end was a lemon that tasted somewhat bitter. However, here is the way it was done:

We are on a construction job where we have so little use for brass or copper that we do not stock any, therefore I could not find any brass that I could use as a filler, not even a cent, so it had to be a case of build it up with brazing rod as filler.

In the first place I filled the pipe full of fairly moist clay, then standing it on end I banked it up from bottom to top with wet clay, making a cup at the top in which I kept adding a little water, then I lighted my torch and started warming up the wall of the pipe, just the end (that was all that was visible), and it was a very delicate business. As the end of the pipe began to get warm I sprinkled a little borax on the clay that was inside of the pipe. The reason for the borax is that when the first melting of the brazing rod occurred it liquified instead of remaining in a ball and oxidizing as would be the case without the borax.

Then when this liquid or molten brass was level with the top of the pipe walls they too commenced to melt and mix, thereafter I carefully increased the height of the deposited brass until there was enough to allow for rounding off, and then I left it for an hour or so to cool off.

Upon returning to the job I took off all the clay and looked it over, and it was really a "grand and glorious feelin'," not a bit of plating had peeled off, nor had it become tarnished. The clay inside being now dry was easily reamed out with an ordinary long screw driver and the extra metal removed and rounded off to a nice ball shape. I am willing to admit that there was quite a bit of decorating in order to do this job but, as you know by now, sour lemons need a lot of sugar.

THE ARC-WELDED SEAM JOINT

By C. R. Wendler

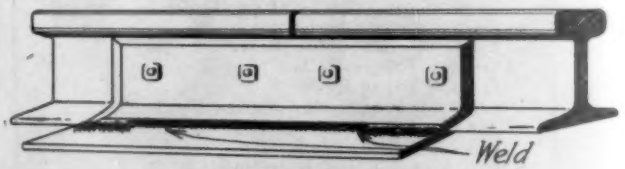
Today the solid, permanent joint is much sought for and has been attained by several methods of welding. The chief method on some lines is to use the arc-welded seam joint.

This type of joint has several advantages. The equipment, or welding machine, can be purchased for about $400 and up, and used for other purposes.

Then there is the elimination of preheating and other extra preparatory work which adds to the cost per joint.

There is no reason that the arc-welded seam joint should not prove a perfect joint.

The arc-welded seam joint is exceptionally good for special work, such as crossings, curves and switches, which have many short lengths of rail and are always getting loose and causing frequent repairs, thus adding to the maintenance.



Arc-Welded Seam Joint.

In repairs to old work the writer has found the following method to be good: After the joint has been tightened up, nut locks not used for both heads of bolt and nuts are welded to fish plates, also nut is welded to the bolt. By doing so the nut is held absolutely tight and cannot let the bolt get loose, thus adding strength to bolt.

The bottoms of fish plates are heavily welded to base of rail, and under the base of rail at joint is welded a plate ½x8x24 inches. As 12 inches of the base of each rail is heavily welded to this plate, on both sides of base, and the two fish plates are also heavily welded, one can see that a cheap, solid and even joint is obtained.

Also we have a perfect conductor for current in this arc-welded seam joint, and the cost of about 53 cents per bonded joint is done away with while making a solid joint, thus adding to the favor of this type of joints.

Some electric railways make the most of their curves and other special work. Especially on crosses the electric arc can play an important part.

MOTOR BLOCK REPAIR WITHOUT PREHEATING

By C. M. Johnson

This motor block had the main bearings run in and could not be taken out. The hole at the bottom was caused by a connecting

$100.00 FOR THE BEST STEEL WELD

The UNITED STATES WELDING COMPANY, makers of "U. S." Oxy-Acetylene Welding and Cutting Equipment believe that steel, although welded extensively, presents more difficulties to the average welder and is less understood by him than any other metal in common use. Too many operators are satisfied with external appearances and overlook the most important point of THOROUGH FUSION. In order to stimulate interest and furnish an incentive for these welders to examine and improve their own work, thereby raising the standard of welding, the UNITED STATES WELDING COMPANY offers a cash prize of $100.00 for the best Oxy-Acetylene Weld made in steel plate and submitted for examination before March 1st, 1924.

Since the purpose of this offer is to elevate the standards of welding, contestants will be limited to those actively engaged in welding.

CONDITIONS

1—Contestants must be men who are actively engaged in welding. Salesmen, Demonstrators and Instructors are not eligible for this competition. It is, however, open to Shop Owners who do some of their own work; Foremen who spend part of their time in actual welding, and Supervisors who spend a part of their time in actual welding.

2—It is desired to standardize upon the size of samples as much as possible without making the selection of stock too difficult. Each of the two pieces to be welded together should be ½ in. thick, 3 in. wide and 6 in. long. These dimensions are the minimum limits. Slightly larger stock can be used. The ends of these parts are to be butt welded so as the cross section of the weld when broken will be ½x3 in. The weld must be made from ONE SIDE only and left flush with the surface. Do not reinforce. Contestants may select their own stock, filler rod, pressure, etc.

3—While each contestant is limited to one sample, he may make as many samples as he desires in his own shop and submit the one which he thinks will represent his best efforts. The contestant must break his own sample THROUGH THE WELD. Retain one-half for identification and send us the other half.

4—The Coupon below must be filled out IN FULL and accompany the sample. (Do not paste coupon to sample.)

5—All pieces submitted must reach our office by noon, March 1st, 1924.

No deposit or fee is required, nor is the contestant under any obligation whatsoever.

INSTRUCTIONS

Select your own stock; Prepare the weld according to your own ideas; Weld from One Side only; Break your weld cold in a vise; Break must be made through the weld itself; Send one-half prepaid to the address below, with the coupon completely filled out and tied to your sample.

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This coupon must be attached to every sample which is submitted.

Do not paste coupon to sample.

(1) Date.....

United States Welding Co., Inc.,
Minneapolis, Minn.

I hereby certify that this weld is my own work and that I make my living by welding.

Name .....

Street .....

City .....

Employed by .....

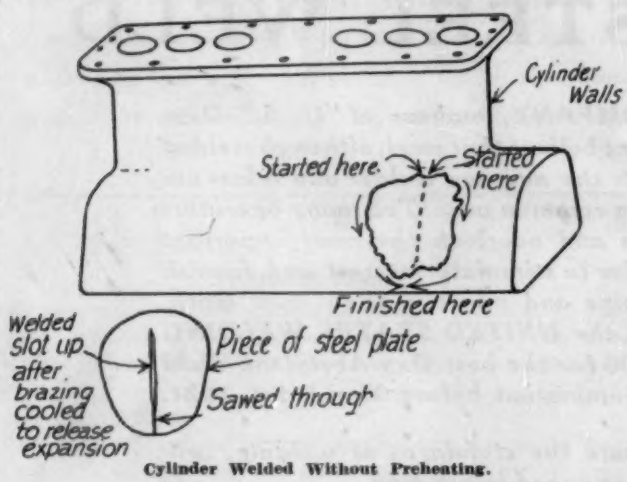
Make of Torch used .....

Make of Acetylene used .....

Make of Oxygen used .....

Make of Filler Rod used.....

rod coming loose. The owner did not want to have the block preheated because he was afraid that it would be warped out of shape. In order to make the repair without preheating we took a piece of sheet steel about ⅛ in. thick and shaped to the size of the hole, letting the edges lap over about ¼ of an inch. Then we used a hack-saw to saw from one end down through the center to about ¼ of an inch to the edge. We laid the piece of steel over the hole and commenced brazing from the center down to the edge, then brazed from where we had started around to the other edge, leaving only the opening made by the hack-saw. We waited about an hour for it to cool, then welded the hack-saw cut with the steel rod. We found that by cutting this little slot we had taken care of the expansion and contraction very nicely, so that our repair was a permanent one and the block was in perfect alignment when it was finished.



Cylinder Welded Without Preheating.

BUILDING UP TIRE FLANGES

By H. D. Odell

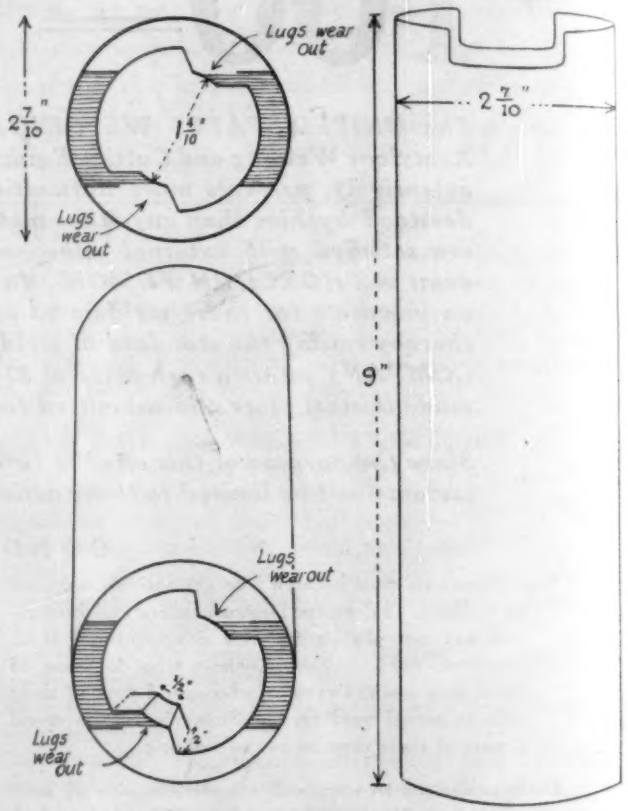
I happen to be on a railroad that is mostly curves, and consequently it is very severe on locomotive tires. In building these tire flanges up it has been a hard matter to find a welding rod which would flow smoothly and yet be hard enough, after passing through the electric arc, or if it were hard enough it was almost impossible to get it to fuse with the tire. At least I thought so for a while, and rejected several samples of rod on that account. Finally I reversed the polarity of the welding machine just to see what action it would have on hard rod (trying the remnants of samples), and I found that those I condemned the worst showed up the best; fusing with flange in good shape, and smoothly enough not to interfere with running condition of engine. I find that the more you become accustomed to the rod the nicer job you can do. It being comparatively easy to get two drivers in six hours, as against five to seven hours each with acetylene.

Much of the rod I find suitable for this work is advertised as acetylene rod, the advertiser evidently not knowing he has an equally good rod for electric purposes.

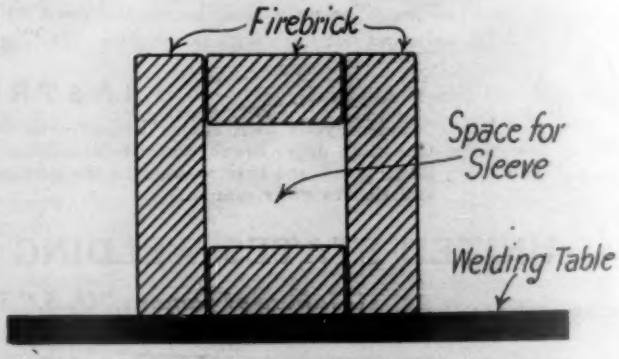
WELDING SLEEVE OF ROCK DRILL MACHINE

By J. H. Arnison

You will notice by the sketch what they look like, and I may say we are the only firm in this country that are making a success of same. The welding rods we use are the scrap pieces of haulage cable that are laying about the mines here. We only started to use it after many tests, as it gave the best results of all the material we tried. It is a high carbon steel, some people call it plow steel. First of all we have firebricks arranged, as you will see by the sketch, so as to keep the heat in the sleeve. Then we make the sleeves red hot in a smith's fire, put it in the oven, and start welding. This is how we do the welding: we set the torch to a neutral flame, then with the neutral flame we build the lug up about ⅛ of an inch, then we adjust the torch to a carbonizing flame, that is an excess of acetylene about ½ an inch, and finish that lug, then we turn the sleeve around and do the other lug the same way, when that is finished we put them in powdered asbestos, so as to let them cook slowly, then it is easier to machine them. We then machine them to size and harden them; they last approximately as long as a new one. There is one thing I forgot to mention, that is we use a good cast iron flux when we are welding the sleeves.



Method of Repairing Sleeve.



Use of Firebrick.

COURT DECIDES GENERATOR IS SAFE

An interesting decision was rendered in Circuit Court at Chippewa Falls, Wis., when Judge E. C. Higbee, of LaCrosse, sitting for Judge James Wickham, directed a verdict ordering Fred Olmstad, a Chippewa county farmer, to pay for an acetylene lighting plant, which he has refused to accept on the claim that it was dangerous to use.

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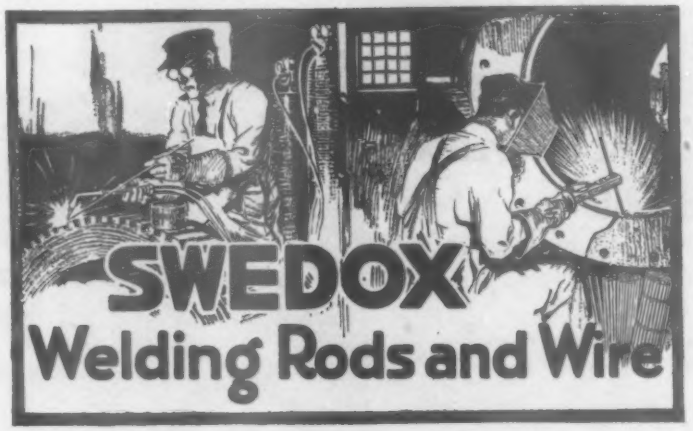

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PUT YOUR WELDING TROUBLES UP TO US Let us prescribe the filler best adapted for your requirements. We maintain a research department conducted by experts for the benefit of our customers. This service is FREE OF CHARGE.

FLUXES—CASTOX, BRONZOX and ALUMINOX FLUXES when used with the corresponding non-ferrous filler rod will keep impurities out of the weld and promote thorough fusion.

FREE trial samples of any product will be furnished upon request. A trial of any SWEDOX product will convince you of its superiority. Send for these samples NOW.

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It serves every possible need for information on all of the welding processes. Whether your shop is engaged in production welding or repair welding, or both, whether you use the processes for only one metal or for a variety of different metals and different types of joints, **The Welding Encyclopedia** furnishes you with expert advice which pays for itself by increasing the quality of your work. **The Welding Encyclopedia** is not restricted to the welding knowledge that can be imparted by a single writer. On the contrary, each subject is discussed by a recognized authority on that particular subject. About fifty of the best known authorities on welding subjects in the world have contributed the results of their experience and research along special lines.

In compiling **The Welding Encyclopedia** the editors have had put at their disposal a vast fund of information which could not be made available through any other source. The result is a single volume covering the entire range of problems which can arise in the application of any of the welding processes, and this information has been so carefully arranged and cross-indexed that any portion of it is instantly located.

The Welding Encyclopedia describes in detail the theory and practice of every welding process, and tells how to weld every weldable metal by each of these processes, giving detailed instructions for handling such important welding jobs as boiler welding, sheet metal welding, tank welding, pipe welding, automobile welding, cutting, rail joint welding, railroad welding, etc.

It tells how to prepare parts for welding, how to preheat, how to anneal, how to test welds and how to select welding material. It explains the meaning of all words and terms found in welding literature. It gives the trade names of all products used in the welding industry, giving the name and address of the manufacturer in each case.

It tells how to take care of welding equipment so as to get the best results from it and keep maintenance costs down. It gives the federal, state and insurance rules and regulations for the installation of welding equipment, and its application to important work. There is also a splendid collection of charts and tables used for welding information, grouped together for convenient reference.

A new and valuable feature which has been added in publishing the Third Edition is a complete chapter on the training of operators. This chapter outlines lessons, exercises and examinations for a complete course in both oxy-acetylene and electric arc welding. Throughout these instruction courses references are supplied to the instructor and student so that they may find instantly the portions of the text which cover the topics in the outline.

The text is profusely illustrated with photographs and drawings made especially for **The Welding Encyclopedia**. No detail has been overlooked which could make **The Welding Encyclopedia** complete and practical.

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gives you the answers

The editorial office of The Welding Engineer is recognized as the headquarters for authoritative information and help on all branches of welding, and conducts a large volume of correspondence helping welders and welding departments out of their difficulties. In a period of eight months it was found that 95% of the problems submitted to this office were answered directly from the pages of The Welding Encyclopedia.

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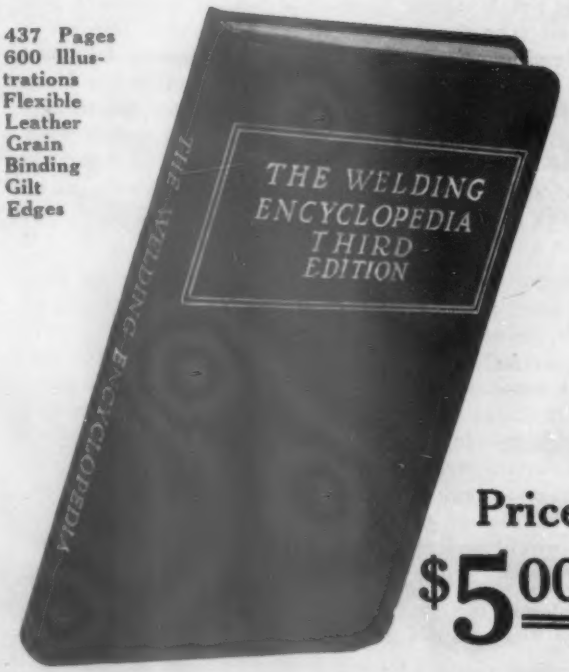

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PRESSURE WELDING COMPETITION

French Welding Society Has Interesting Contest for Welding Small Tanks by Oxy-Acetylene Process

Paris, France.
Friday.

Dear Ed:

"So this is Paris!" Expresses volume. This village is certainly in a class by itself. I imagine first impressions are the most lasting and being different in so many respects to our customs they are mighty interesting.

I won't bore you with any more of my impressions just now for I want to tell you about my visit to the famous "l'Office Central de l'Acetylene et de la Sudure Autogene." As you probably appreciate, the Oxy-Acetylene Welding and Cutting industry owes a great deal to the efforts put forth by the French society. The engineers in charge, namely, Messrs. Granjon and Rosemberg, I had always heard much about so was naturally very anxious to meet them. Being in Rome, so to speak, I decided to do so as the Romans do, so instead of telephoning for an appointment as we would at home, I wrote a letter. I was mildly surprised to have a reply the next day written in English. As you may depend, I was tickled to see that there was someone on hand who could "Parley vous English." The letter was signed by M. Rosemberg, who said he'd be glad to see me at ten o'clock the following day. I was all ready but seeing it was quite a jump from my place I hailed a taxi.

I was met by the interpreter who informed me that Monsieur Granjon was not there. He was still on his holiday (vacation), but Monsieur Rosemberg was in and would present himself very shortly—I liked the interpreter. He had a good sense of humor and spoke very good English. I learned from him that Monsieur Granjon spoke no English but Monsieur Rosemberg knew a little. About that time the famous Rosemberg, himself, appeared. The Frenchmen certainly are affable and M. Rosemberg is no exception. The reception was most cordial. The merry twinkle, which seems to be ever present in his eyes, wins you right away—I'll tell you more about him later.

The laboratories proved very interesting. First, in the general floor plan, are the offices; then comes the assembly or lecture hall; beyond this is the testing shop for welds; next the training quarters; then the testing room for apparatus followed by a museum and experimental laboratory. In the lecture hall, meetings can be held. It is here too, that the students are given lectures. The walls of this room are covered by all the various styles and types of French blowpipes, regulators, gauges, goggles and accessories pertaining to the industry. The shelves are well filled with books and on the tables all current periodicals.

The Testing shop for welds contained various machines for making different tests. These were well arranged and bore evidence of being used a great deal.

The Training quarters were not quite as large as might be expected. The system employed for training is very good and the support received from the different manufacturers is wonderful. All the Oxygen, Acetylene, Carbide, and Apparatus is supplied free by the French manufacturers. They, apparently, are far sighted enough to see that the only way to create more welding is to produce better welders. This they do by education. Not only this, but the whole laboratory is supported by the manufacturers. The oxygen makers bear their share; the acetylene their share; the carbide, apparatus and various producers all carry their share. Even the goggle people contribute. It is all for the good of the cause. As a consequence, if anything is needed, the engineers in charge simply make their wants known and they are supplied.

The room for apparatus testing is well supplied with equipment for accurately gauging and checking the consumption of gases used by different makes and styles of blowpipes, stoves, and other gas apparatus.

The last room, which I have called the museum and experimental laboratory, contains many rare sights. Blowpipes of every kind and description can be found here, as well as acetylene cook stoves, lights, acetylene gas engines, etc., etc. As we entered a new type of gas engine was being dmonstrated with the expectation of opening up another field for acetylene. Some antiques in the torch line were well worth charging an admittance to see.

In a detached building the working acetylene generators are kept. Some of these were so very much different from any others that I had seen that I had them explained in detail. One in particular was rather novel. It was of the detached bell type. The main generator had a series of cups arranged around the circumference of a four foot circle. As the gas bell receiver dropped, it caused one of these cups to empty its charge of carbide into the generator, thus generating enough gas to refill the gas bell.

A very interesting series of tests had recently been completed by the laboratory and I was mighty glad of the opportunity of going over these with Monsieur Rosemberg. It seems that l'Office Central De l'Acetylene had appointed a committee, including some of the biggest engineers in France, to act as judges in a contest for welders. The object being to gain a general conception of the relationship between various welders working under similar conditions. You can imagine what a beautiful time this committee must have had scheming out a general plan, but they did it with the thoroughness which always characterizes the French.

It was decided that fifty welders would be allowed to compete. The objects to be welded would be steel cylinders measuring approximately 26 inches long by 4 inches in diameter. The steel to be of 10 gauge. The welding to be done was as follows:

1st. The long seam.
2nd. Both ends.
3rd. A pipe nipple in one of the ends, to permit testing.

This meant that there was to be about fifty-two inches of welding on ten gauge steel. The parts to be welded, namely the shell of the cylinder, the two ends and the pipe nipple were all prepared beforehand by one of the manufacturers. All the operator had to do was assemble it and do the welding. Of course the best grade was scheduled for the fellow doing his job in the fastest time; using the least amount of Oxygen and Acetylene, and producing the best looking and strongest weld. However, the fastest operator might not be the one producing the strongest weld so provision had to be made to take all things into consideration. In arranging for the grading of the results the following rules were made:

1st. Acetylene gas consumed: 2 points for every 10 litres registered.

2nd. Oxygen gas consumed: 2 points for every 10 litres registered.

3rd. Time for completing the test: 2 points per minute.

4th. Hydraulic test: 2 points per each kilo constituting the difference between the bursting pressure and that of 150 kilos. On the other hand if the cylinder bursts at a greater pressure than 150 kilos, there will be deducted as many points as the kilos registered more than 150 kilos.

5th. The appearance: These points to vary between 0 and 50.

At first when this was explained to me, I couldn't quite make out why, if it was points they were awarding, that the

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greater the gas consumption the more points were credited; while the higher test resistance should take away points. than the highest that counted most. I was presented with a little chart showing the results in a nutshell. If you follow it Finally I saw that it was the lowest number of points, rather through you can easily see how it works.

Just follow No. 1 across with me.

Time—29′ 30″ @ 2 points per minute	59
Acetylene Gas—163 litres @ 2 points per decalitre	32.6
Oxygen Gas—186.4 litres @ 2 points per decalitre	37.3
Total points on time and gas	128.9
The weld is then graded according to its appearance. It is awarded	17
Next the Hydraulic test is given:	
It bursts at 118 kilos.	
The difference between 150 and 118 multiplied by 2 equals	64
GRAND TOTAL	209.9

Brings placement number of 32.

These figures seem to fascinate me, Ed. I don't know whether they will appeal to you in the same sense as they do me or not. It really don't make any difference where these tests were made, whether in one country or another;

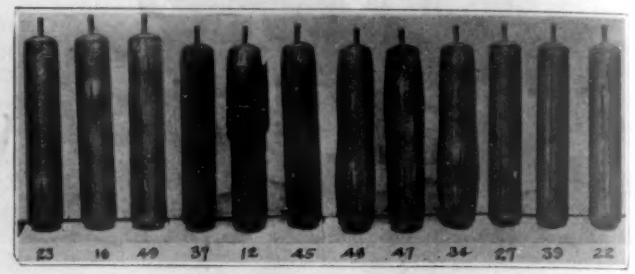
SHOWING RESULTS OF 50 COMPETING WELDERS

Numbers Given Operators	Numbers of the Cylinders	Time of Welding in Minutes	Acetylene Consumption in Litres	Oxygen Consumption in Litres	Appearance of the Weld Points 0 to 50	Hydraulic Pressure Test	Total Points Deducting Bonus Points if There Are Any	Grade
1	41	29′30″	163	186,4	17	118	209,9	32
2	43	29′	150	175	15	134	170	16
3	44	44′	195	257	14	170	172,4	18
4	15	39′30″	132	152	16	123	205,8	31
5	6	26′30″	143	170,7	14	146	137,7	6
6	9	43′30″	138	159	18	167	147,4	10
7	36	49′	209	300	24	154	219,8	37
8	38	40′	149	188,5	14	134	193,5	26
9	24	38′30″	178	250,7	19	170	152,7	12
10	40	43′30″	201	273	12	163	180,8	20
11	46	48′30″	199	243,5	29	153	211	33
12	49	38′	192	232	26	134	218,8	36
13	11	30′30″	172	181,4	18	143	163,7	15
14	37	37′	160	171,4	15	170	135,3	5
15	42	40′30″	186	195,7	14	136	199,3	29
16	2	56′30″	258	297,8	22	170	228,1	41
17	22	41′30″	181	191	17	154	170,4	17
18	28	37′	218,5	255	21	146	197,7	28
19	25	55′	208	228,5	23	152	218,3	35
20	21	20′	112,5	137	16	147	129,9	2
21	19	31′30″	178	189,2	24	154	156,6	13
22	[illegible]	[illegible]	194	267,8	17	154	191,3	25
23	5	49′30″	261	285	16	149	226,2	40
24	15	40′	170	197,8	11	156	158,5	14
25	30	41′	130	159	9	166,8	132	4
26	20	36′30″	138	159,5	17	116	217,6	34
27	48	38′	164	172,8	5	170	128,3	1
28	35	44′30″	241	261,4	17	135	236,5	43
29	1	45′	221	256,4	18	170	183,5	21
30	32	51′	225	287	16	121	278,4	49
31	31	31′	125	138,5	15	145	139,7	7
32	10	56′30″	226	235	27	138	256,2	46
33	34	52′	294	340	15	121	261,8	47
34	14	64′	252	272	20	149	254,8	45
35	8	32′30″	144	176,4	19	112	224	39
36	47	37′30″	165,8	178	20	170	143,7	8
37	18	25′	193	207,8	26	117	222,1	38
38	26	55′30″	271	295	26	159	241,2	44
39	17	61′	170	195	13	162	196	27
40	33	61′	294	342,8	25	160	264,3	48
41	45	50′30″	223	251,4	15	170	190,9	24
42	7	44′	224	232,8	18	157	190,3	23
43	29	32′	123	132,8	22	129	179,1	19
44	39	43′30″	230	250	24	101	395	50
45	23	44′	189	198	20	150	185,4	22
46	13	35′30″	132	155,7	24	154	151,5	11
47	50	31′	133	162	20	159,2	131,8	3
48	27	49′	185	208,5	18	129	236	43
49	12	38′30″	176	205	12	170	145,8	9
50	3	32′	143	177	23	125	201	30

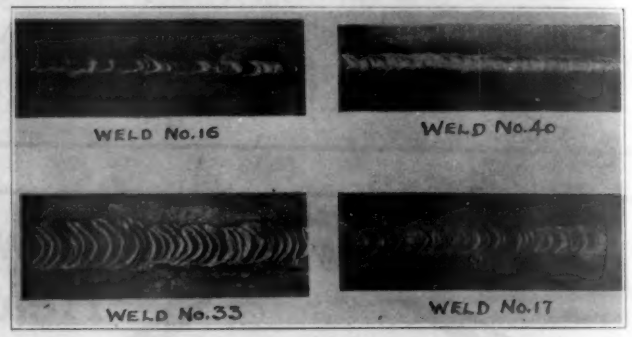
here we have valuable data, not on the work of beginners but of experienced welders. Let us glance over some of these figures, Ed. I'll gamble you'll gasp for breath. Take Welder No. 37 for example: His time to execute the fifty odd inches of welding is 25 minutes, whereas Welder No. 34 takes 64 minutes. In other words, No. 34 requires more than 150% more time to do the same work than No. 37 does. Their final marks are 38 and 45 respectively.

Let us apply the same comparisons to the gas consumption. Here we have Welder No. 33 using 294 litres of Acetylene and 342 litres of Oxygen. His final mark is 48. Welder No. 20 on the other hand does the same amount of work on less than half of No. 33. His consumption as you see was 112.5 and 137 litres respectively. But look at his final mark, 2; next to the best welder in the whole lot of fifty. Incidentally, in addition to the smallest gas consumption, this man made next to the fastest time. However, his weld was not as good as it might have been, you see it broke under a pressure of 147 kilos. This is a little below average, if 150 kilos is to be construed as such.

Welder No. 7 seems to have done quite a strange thing. He has used 209 litres of acetylene to 300 litres of oxygen. In other words about fifty per cent more oxygen was used than the ideal "one to one" ratio. But despite this fact and the fact that the judges said his weld didn't look very good (evidence by the point 24 awarded) the hydraulic test showed that it was a weld above the average.



A Few of the Welded Cylinders.



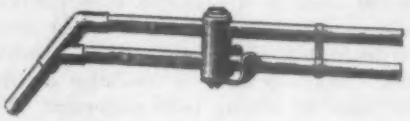
Welds Submitted in Competition.

It is interesting, too, to note how many real good welds are to be found in this list. Take Nos. 3, 9, 14, 16, 27, 29, 36, 41 and 49, these all show the maximum test of 170 kilos. When nine welds out of fifty hit this mark it is a mighty good showing. But when we go further and see that there are only sixteen of the balance that were over the average, it's high time that the welding industry takes or makes time to emphasize the importance and difficulty surrounding good steel welding. It was just before I came to Europe that I heard of one welder condemning another because he referred to a "neutral" flame for steel welding, which was so soft that it was "sparkless." I couldn't help but think of that particular chap when Monsieur Rosemberg was telling me about the tests of these experienced welders. Welders seem to be the same the world over; all given to shouting their own praises and never conceding that there might be a point or two which they overlooked occasionally. If this unbeliever in "Sparkless" flames really knew how to weld steel he would certainly appreciate the importance and desirability of such a flame.

Thinking perhaps the French engineers had worked out some kind of a solution whereby the welding fraternity could be saved and some of these "Sparkless" heathens converted, I put the question square up to Monsieur Rosemberg. I did so at a very inopportune moment however, for just then the whistle blew; he glanced at his watch, "Ah! twas ze lunch time," so out we went to dine at one of those clever cafes.

Will tell you more next time. As ever,

SHEP.



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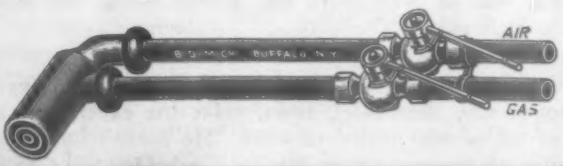

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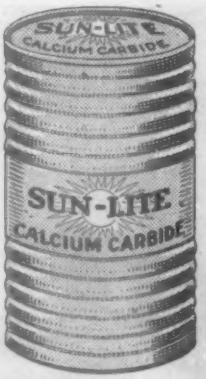

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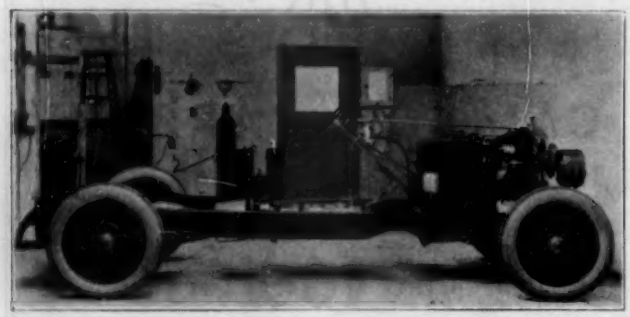
ACETYLENE WELDING EMPLOYED IN MANUFACTURE OF DOBLE STEAM CAR

By C. W. Geiger

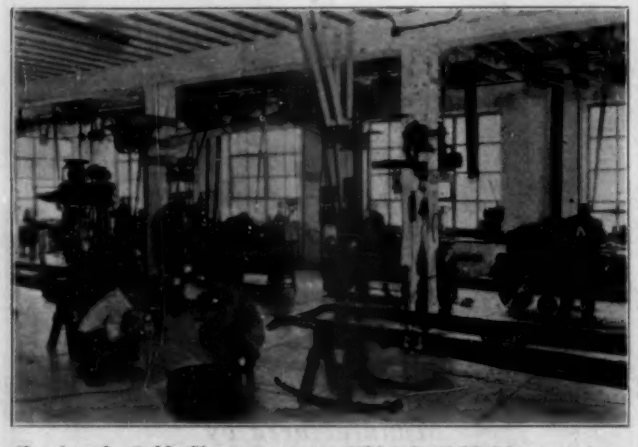
Accetylene welding is used extensively in the manufacture of the Doble Steam Automobile, which is claimed by its inventor, Abner Doble, to have reached the stage of perfection in steam propelled automobiles. A large plant is now under construction in Oakland, Cal., where the Doble steam car will be built.

The steam generator is a single tube 476 feet long, made up



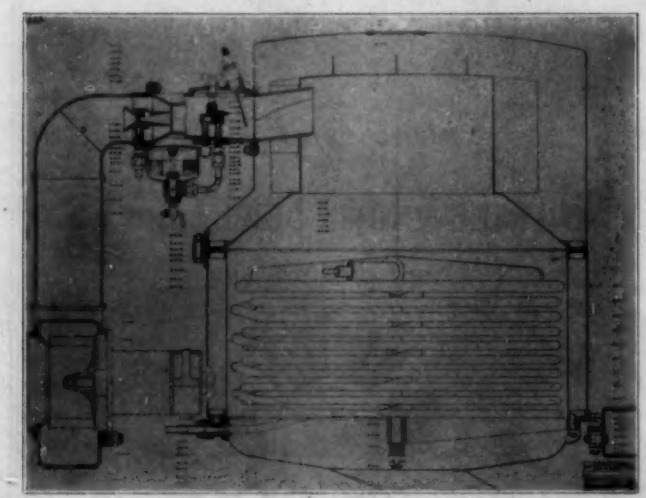
The Doble Steam Car Chassis—the Steam Generator is Welded by Acetylene.

of twelve spirally wound coils of seamless steel tubing, starting with ½ inch diameter, 16 gauge tube at the bottom where the feed water enters and increasing to a tube 13/16 inch diameter,



Showing the Doble Steam Generator Which is Welded by Acetylene.

5/32 inch thick at the top where the superheated steam leaves the generator. Joints are made alternately by the center and outside edges by acetylene welding. After the welding, tubes are tested



Doble Boiler and Burner Assembly.

for leakage at 10,000 pounds pressure per square inch. Spacers are placed between the layers of coils and are welded both top and bottom. This generator contains 75 square feet of heating surface. The coil assembly is supported from the bottom of the casing. This casing is composed of a nichrome inner shell and an Armco iron outer shell welded to 1½x½x⅛-inch steel channel top and bottom. Silocell is used for insulation and the casing is hung from the frame by a three point suspension. The combustion chamber is so designed that the fire whirls within the combustion chamber and does not strike the generator coils.

News of the Welding Trade

The Louisiana Oxygen Co., Inc., New Orleans, La., was recently elected to membership in the Gas Products Association as an active member. The Pittsburgh Reinforced Brazing & Machine Co. have been elected to membership as an associate member.

Mr. Bordeaux of the Michigan Oxy-Hydric Co. keeps his gas customers reminded of the scope of his business by using a rubber stamp on his invoices which reads "Do you know that we sell high grade regulators, torches, generators and supplies for welders?"

Major James Caldwell, Managing Director of the Alloy Welding Processes, Ltd., London, and one of the foremost authorities in the British Isles on the subject of electric welding, was in New York this month for a two weeks' visit.

Mr. A. J. Russell, President of the Bettendorff Oxygen Hydrogen Co., Bettendorf, Iowa, made the experiment this year of taking two weeks' vacation. He doesn't furnish any statistics on the number of fish he caught, but says he had so much fun that he contemplates making it an annual event.

The January meeting of the Gas Products Association will be held in Chicago, January 17th, 18th and 19th, 1924. Arrangements have been made for a special car to accommodate members of this association who wish to go to New York City to attend the winter meeting of the Compressed Gas Corporation Association, which starts the first of the following week.

The Hauck Mfg. Co., have just issued a new bulletin No. 506, illustrating and describing the new Hauck Venturi Low Pressure Burners. Copies can be secured by addressing the Hauck Mfg. Co., 126 10th St., Brooklyn, N. Y.

Attention has been called to the fact that when cylinders are shipped by express the American Railway Express Co. requires two tags on each cylinder. It has also been suggested that these tags be attached separately, so that if one is lost the other will remain.

The plant of the Lincoln Electric Co. has been moved to new quarters at Coite Road and New York Central Lines, Cleveland, Ohio. The new plant has a private switch from the Cleveland Belt Line connecting with all railroads. It covers over 185,000 sq. ft. for manufacturing space. All departments are now moved to this plant and are in full production.

The Chicago office of the Transportation Engineering Corporation recently moved from 220 S. State St. to 327 S. La Salle St. Mr. H. R. Pennington, formerly supervisor of the Rock Island Lines has joined the staff of the Transportation Engineering Corporation.

Mr. Lorn Campbell and Lorn Campbell, Jr., have returned from their trip to Europe and are back on the job with the United States Welding Co., Minneapolis. They report a very pleasing and interesting trip, as well as a very profitable one, having been successful in making important business arrangements with well known European firms.

INTERNATIONAL ACETYLENE ASSOCIATION MEETS IN CHICAGO.

As this issue of *The Welding Engineer* goes to press, the International Acetylene Association is holding its 24th Convention in the Hotel Sherman, Chicago.

Registrations indicate that the attendance will break previous records. Committee reports and talks show a decided advance in the Acetylene Industry during the past year and point to possibilities to further progress.

Program is as follows:

Wednesday, November 14th

10:30 A. M.—Address of Welcome.....Wm. S.Noyes
Response .....F. J. Napolitan
President's Address.....David Ahldin
Secretary's Address and Report.....A. Cressy Morrison
Report of Treasurer
Report of Auditing Committee
Committee—P. Kearny, J. T. Earl, W. A. Cochrane
Reports of Committees
Legislative & Insurance.....A. Cressy Morrison, Chairman
Membership.....Harold W Cook, Chairman
Appliance.....E. L. Davis, Chairman
Portable Apparatus.....O. F. Ostby, Chairman
Training of Welders.....George J. Coleman
Address....John Plant, Chief Engineer, Bureau of Fire Prevention and Public Safety, Chicago
2:30 P. M.—Report of Oxy-Acetylene Committee....C. A. McCune
Committee—G. O. Carter, A. S. Kinsey, E. L. Mills, Wm. D. Flannery, S. D. Winger, A. A. Krebs, W. A. McDougal.
Welding and Cutting in Connection with Car Repair.....
.....H. W. L. Porth, Swift Refrigerating Co.
Large Gas Holder Fabricated by Oxy-Acetylene Welding.....
.....G. O. Carter
Research and Development of High Pressure Gauges.....
.....H. Thurston Owens
Manufacture of Cylinders.....National Tube Co.

Thursday, November 15th

10:30 A. M.—Discussion of Underwriters' Rules Pertaining to Acetylene Generators and Acetylene Equipment.
Report of House Lighting Committee.....P. A. Rose
Committee—Louis Franz, H. Offutt, C. W. Kimball, H. A. Adams, W. C. Swift, J. A. Johnson.
House Lighting.....H A. Adams
Uses of Carbide Residue.....F. B. O'Connor
Publicity Dealing with Acetylene.....Stuart Plumley
2:30 P. M.—Visit to Imperial Brass Manufacturing Company's Plant.
Evening—Theatre Party.

Friday, November 16th

10:30 A. M.—Oxy-Acetylene Machine Welding.....F. E. Rogers
Pipe Line Welding.....N. E. Wagner
Welding Rotary Lime Kiln.....R. R. Orwig
Acetylene.....J. A. Nieuwland
Regulator Construction.....E. L. Mills
New Uses of Carbide and Acetylene.....F. B. O'Connor
2:30 P. M.—General Facts About Oxygen of Interest to the Trade..... Herman Van Fleet
Acetylene from the Viewpoint of the State Fire Marshal.....
.....Newman T. Miller
Presentation of Morehead Medals
Report of Resolutions Committee
Committee—E. L. Davis, M. M. Smith, M. Kirchberger
Election of Officers
Evening—Banquet.

Classified Ads

Help Wanted—75c per line, minimum 4 lines
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Other Ads—$1.00 per line, minimum 4 lines.
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STATEMENT OF OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

of The Welding Engineer, published monthly at Chicago, Ill., for Oct 1, 1923.

State of Illinois—ss.
County of Cook—ss.

Before me, a Notary Public, in and for the State and county aforesaid, personally appeared L. B. Mackenzie, who, having been duly sworn according to law, deposes and says that he is the owner of The Welding Engineer, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, L. B. Mackenzie, Chicago, Ill.; Editor, L. B. Mackenzie, Chicago, Ill.; Managing Editor, H. S. Card, Chicago, Ill.; Business Managers, None.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.) L. B. Mackenzie, 7131 Crandon Ave., Chicago, Ill.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is..... (This information is required from daily publications only.)

H. S. CARD—Manager.

Sworn to and subscribed before me this 27th day of September, 1923.

(Seal) WILLIAM LEIZBACH—Notary Public
(My commission expires April 17th, 1925.)

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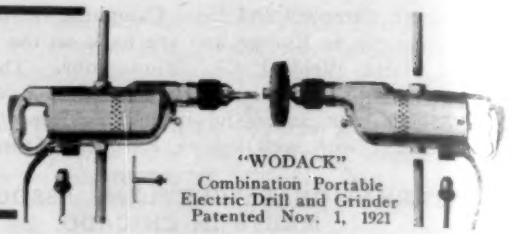

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CURRENT WELDING NEWS

TANK BUILDING PROFITABLE FOR THE OXY-ACETYLENE PLANT OWNER, by David Baxter—An elementary discussion of the possibilities of increase in profits of the welding shop by manufacturers of tanks and other metal containers—Instruction as to the position of flame in filler rod and method of manipulating the torch for Ripple Welding—The use of wedges to control contraction, and a few tank joint designs.—American Blacksmith Motor Shop, October.

WELDING IN LOCOMOTIVE REPAIR SHOPS—Particulars regarding the various welding operations that have been profitably employed in locomotive repair work—List of Locomotive parts repaired by Oxy-Acetylene Welding—Instructions and illustrations regarding Frame Welding—Cylinder welding—Piston Rods and Pistons—Procedure for welding wheel centers—Description of miscellaneous welds made in the locomotive shop.—Acetylene Journal, November.

MAINTAINING OXY-ACETYLENE EQUIPMENT IN SERVICE—Instructions for up-keep and repair of Acetylene Generators—Details of Medium Pressure Generators—Construction of Acetylene Pipe Lines.—Acetylene Journal, November.

WILSON PLASTIC-ARC WELDING—New catalogue of the Wilson Welder & Metals Company, New York City. Contains a short treatise on the economy and value of welding in the industry, showing why Arc Welding is used, where Arc Welding is used, typical examples of welding, what Electric Arc Welding is and the advantages of Arc Welding. Notes on the installation and care of machines—The selection of operators—The selection of Welding Rods and photographs of important applications of the process. Sections are devoted to Plastic Arc Welding Machines and Color-Tipt Welding Metals.

INDUSTRIAL APPLICATIONS OF WELDING AND CUTTING, AND THEIR POSSIBILITIES—An outline of the progress which has already been made in extending the field for application of the welding process, and the possibilities of further extension—The field for Arc Welding, Electric Arc Cutting, Oxy-Acetylene Welding—Oxy-Acetylene Cutting—Resistance Welding and Thermit Welding.—Journal of the A. W. S., October.

BOILER WELDING—A brief and non-technical description of welding Fire Box cracks—Cracks in Sheets—Cracked bridges in Flue Sheets—Patches in Flue Sheets and Caulking Edges.—SMITH-O-GRAMS, October.

OXY-ACETYLENE TIPS—Monthly publication of Linde Air Products Company. The November issue contains the following: Aluminum and Copper Appliances Fabricated by Welding—Twenty Ton Bulldozer Base Repaired—Oxy-Acetylene Cutting Replaces Forging on Heavy Flanges—Blowpipe Facilitates Installation of Iron Grills—Welded Pipe Sustained by Test of Time—Welded Well Driller Built of Reclaimed Pipe—Salvaging Skulls—Fabricated Steel Cylinder Heads for Gas Engines—How the Cement Industry Economizes by Extensive Applications of Oxy-Acetylene Welding and Cutting—Huge Aluminum Still Oxy-Acetylene Welded.

OXY-ACETYLENE WELDING IN RAILROAD CAR SHOPS—A general description of the work done in the plant of the General American Tank Car Corporation, at East Chicago, Indiana, describing the Oxy-Acetylene Installation—The Scope of Reclamation Work—The Central Welding Shop—The Use of Cutting for Demolition and the Use of Welding and Cutting in Production.—Machinery, November.

ARC WELDING CAST IRON WITHOUT PREHEATING, by J. P. Kryza and H. E. Bradford—Description of a Method for Welding Cast Iron with the Electric Arc—A Short Arc Is Used and the Metal Deposited in a Series of Laminations—Commercially Pure Iron Wire Is Used for the Electrode—Care Is Taken to Fuse the Surface as Little as Possible to Avoid Crystallization.—Machinery, November.

STANDARDIZING WELDING OPERATIONS FOR PRODUCTION USES, by Harold Lang—A general discussion showing how defective castings in Automobile Manufacturing Plants are repaired or corrected at once by the Welding Torch. It is pointed out that better results are obtained by having many helpers to assist the welder.—Canadian Welding Journal, October.

WELD BROKEN ALUMINUM CASTINGS WITH OXY-ACETYLENE TORCH—Some elementary instructions for Aluminum Repair Work—Special emphasis is laid on the necessity for cleaning the edges around the break and using a good quality flux.—Canadian Welding Journal, October.

SLOWER THE BETTER IN WELDING, by Dr. C. L. Aitchison—Giving the Reasons Why High Speed Is Not Desirable in Welding—Heating Metal Too Quickly Produces Sudden Stress of Great Distortion, and Normalizing Is Often Needed.—Canadian Welding Journal, October.

THEORY AND FACTS TO AID IN THE CHOICE OF AN EFFICIENT ELECTRIC ARC WELDING SYSTEM, by D. T. Smouth—Digest of a Paper Read at the First Meeting of the Institution of Welding Engineers, in London—The Chief Factors Discussed as Affecting the Work Are Electrode, Current, The Welding Machine, and the Operator—The Speed of Welding Enters Into the Question of Cost, Providing Increased Speed is obtainable Without Loss of Welding Efficiency.—Acetylene and Welding Journal, London, October.

OFFERS CASH PRIZE FOR BEST STEEL WELD.

The UNITED STATES WELDING COMPANY, Minneapolis, Minn., is announcing a Prize Contest for Welding Operators, in an endeavor to make welders take more interest in the quality of their work and make tests of their own work so that they can see for themselves how their welds look on the inside. They believe that the correct method of welding steel is neither well understood nor well applied, and that a great many steel welders are judging the quality of their work altogether by external appearance. They are offering a cash prize of $100.00 for the best steel weld, 3 inches long, made in one-half inch steel plate, and not reinforced. They require that those who participate in the contest shall break their own sample, through the weld, sending only ½ of the broken sample for examination. They do not restrict those who take part in the contest to the first sample attempted. There are no restrictions on the grade of steel used on the job, although reasonable restrictions are applied to the dimensions to the piece submitted. Operators are encouraged to make repeated efforts to secure the best possible weld, and are given a free hand in the matter of preparation, selection of tips, pressure, etc. This is a very interesting contest inasmuch as it will cause many men to do what they have not done before, that is break one of their own welds. It is believed that the majority of those who participate will attain some interesting information on the quality of their own work.

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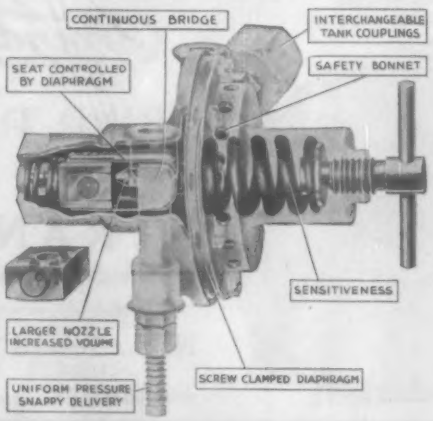

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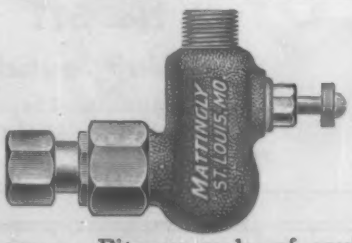

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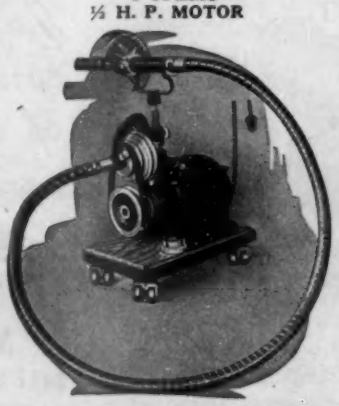

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